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THE FUTURE OF MYCOLOGICAL RESEARCH IN INDIA

MYCOLOGY touches upon a number of other sciences and in turn is influenced by them. Amongst the applied sciences in which it has long been of importance, first and foremost comes plant pathology, closely followed by soil science. More recently it has begun to play an increasingly large role in chemistry. It is of significance in human nutrition. In medicine, where it has hitherto taken a comparatively minor place, it has in the past three or four years loomed large. As a branch of botany the study of the fungi themselves has long been interesting and important because the fungi provided useful and comparatively easy material for the study of form, of physiology, of specific relationships, and particularly of sexuality, where it has been possible to observe processes taking place in small groups of cells under a high-powered microscope *in vivo*. The classification of fungi is unique inasmuch as they represent the largest group of living things which are classified mainly on the basis of micro-morphology. The result has at times been a tendency to place undue emphasis on minor morphological characters which has often led taxonomy into disrepute, but the realisation in recent years of the immense significance of fungi in a wide range of human activities has compelled the applied mycologist to return to the field of taxonomy with increasing energy and to devote to it a measure of time and skill which was hardly imagined a generation ago.

This diversity of activities of mycologists is to-day giving rise to certain serious and difficult problems of organisation. There is now a need for teams of skilled workers having a profound knowledge of the habits of fungi from entirely different points of view and with bearings on completely different problems. In plant pathology, the mycologist must have a deep insight of plant physiology, agronomy and taxonomy, accompanied by some understanding of both organic and inorganic chemistry, which is called upon constantly for the control of plant diseases by the use of chemicals and by other methods. In soil mycology, a subject sadly neglected in India, an understanding of soil physics and chemistry, as well as bacteriology, is essential. If the useful fungi are to be developed in India, it can only be possible by the collaboration of mycologists with biochemists and nutrition experts. In the realm of fungal therapeutics, there is need for skilled research workers possessing adequate and well-equipped laboratories for research on human and animal medicine, as well as first-class biochemists, all working in teams. Modern inventions of food processing, the fabric industries, leather, timber, and (in rapidly expanding measure) electrical equipment, are facing problems due to fungal damage of a very special nature, requiring a type of technological expert not known a few years ago. These problems would not be difficult to solve were it not for the fact that mycology is in itself a

separate science requiring wide knowledge and the ability to grasp the fundamental relationships of a great range of micro-organisms. The problem of organising research in mycology, is, therefore, one of co-ordinating the activities of specialists in a science who have to be distributed and carry on their work in a number of quite disconnected branches. It is, in fact, a problem of so directing the activities of a group of scientists that their services can be placed at the disposal of a number of unrelated sciences without their losing the unity which they must retain if the science of mycology itself is to advance. It is a problem of how to disperse and yet to integrate.

If anyone does not believe that this is a real problem, let him examine any well-known classification of fungi—that, for instance, of Saccarado, and then read one of the well-known works on medical mycology. If, after mastering the former, he is capable of comprehending the latter after one or even two readings, he will have proved himself to be indeed a master of multiple and confused conceptions. The classification and description and also the terms used to describe the same thing are often quite different; while frequently, on the other hand, the same terms, even the same generic names, are used to designate organisms or organs unrelated both morphologically and physiologically.

We may assume that the nature of the various kinds of work to which we have referred indicate clearly enough that specialist mycologists have to work along with teams of other scientists to which mycology is little more than a name. What we have to decide is the number and nature of the various kinds of specialist mycologists, the type of institution in which they will have to work and how the work of all of them can then be integrated so that unity of terms, conceptions and outlook can be maintained. The organisation and grouping of specialist mycologists proposed here is an attempt to solve this problem.

Plant Pathology

Plant pathology is one of the oldest and still the largest of the activities of mycologists. In India it is organised both centrally (at the Imperial Agricultural Research Institute) and provincially in the various agricultural departments. The earliest work was mere observation by workers in foreign countries on materials sent to them from India. The first pathological research of importance was that of Barclay in Simla. Early in this century work became centralised at Pusa, due, mainly to the outstanding achievements of Butler. With one or two notable exceptions there was little done provincially until Butler's students had become scattered over the provinces.

Pusa was fairly well situated for studying a considerable number of plant diseases. Many crops could be grown there including some which were more or less tropical in nature, although not those most characteristically so. Few, of course, of the diseases caused by the cool climate-loving fungi could be studied. With the removal of the Institute to Delhi, which has a rigorous climate of hot dry summers and rather cold winters, the number of crops which could be worked with was reduced, and even on those on which research was possible, it could be conducted only for a short period of the year. Work under controlled conditions of temperature is impossible apart from a few winter months. The conditions of climate are in fact such that only a dozen or so crops can be studied for any appreciable length of time during the year. The field could be greatly expanded by the addition of a suitable hill sub-station, but none has been provided.

What is true of Delhi is true of any place selected in India, though usually to a lesser degree. There is no one place where all crops can be grown. Plant pathological research requires dispersal on a provincial basis, according to crop geography. The work requires close asscciation with experimental farms, and generally speaking can best be done by agricultural departments of provincial governments.

It is only as a result of recent research that we have appreciated the importance in Northern India of the Himalayas as a possible source of origin of epiphytotics. No province of India consisting mainly of plains with adjacent hills can ignore this possibility, and hill stations for plant pathological research must now be regarded as essential. The extent of India and the variation of climatic conditions as one proceeds from the dry mountains of the west to the eastern hills is such that one single hill station will not suffice. Several will be required.

Soil Science

The role of fungi in the soil received much attention at the beginning of the present century in many parts of the world, but not in India. It is a rather remarkable thing that in India, where the soil is low in humus, and where stress is being laid at the moment on green manuring and increasing the organic matter in the soil, little or no attention has been paid to the agents responsible for the first step in making available to plants the green matter which must be applied if the humus content is to be appreciably increased. Major drawbacks in both green manuring and composting are the conditions required to establish the decomposition and the long time required to complete it, which, in the case of green manures at any rate, is a severely restricting factor in its application. Methods that would induce rapid fungal activity in the early stages, whether by inoculation or by chemical treatment, are essential, yet we know little of the kind of fungi inhabiting Indian soils and next to nothing about their selective properties. Perhaps this is due to an overstressing of the chemical aspects of soil science. At any rate, the close association of mycologists with soil scientists seems to be essential if we are to see useful developments along this line. Much of the best soil science work has been done in our Universities,

and doubtless it will continue to be so. There is no reason why mycologists should not be attached to the soil science departments of all Indian Universities where this subject is taken seriously. Again, however, a very wide outlook and thorough experience of the fundamental aspects of mycology are needed.

Chemistry and Nutrition

In the applied branches of chemistry mycology can be of great assistance. At the present moment India is converting a large amount of molasses into alcohol, which is required for a number of industrial processes as well as for fuel. Whether alcohol as fuel for combustion engines can compete in normal times with mineral fuels is uncertain, but certainly there are other industries developing in India which will absorb considerable amounts. The alcohol industry of the country will not find it easy to hold its own under the competition to be expected in the post-war period. It is essential that production should be efficient, and that the maximum amount of alcohol be produced from a given quantity of carbohydrates. This is only possible if better biological control of the process is followed than is the case at present, where inoculation is largely a matter of chance and the selection and maintenance of suitable strains of yeast receives no attention.

There are other fermentation industries where mycologists are needed. Vinegar and acetone and acetic acid are often produced with little attention to the proper organisms; a citric acid industry, we believe, does not exist, though in other countries the mycological method of producing the acid has taken the place of natural citric acid from fruit.

In all the chemical industries, factories must be established where the raw products exist. Centralisation is impossible except for the more fundamental aspects of the work.

The fermentation methods of producing readily digestable proteins and of rectifying vitamin deficiencies are now receiving attention in India, as in other countries. The possibilities here are great and fascinating, but exploitation demands heavy capital expenditure and a high degree of biological control. Provided these exist, there is no reason why, after the war, large quantities of molasses, and possibly other crude forms of carbohydrates, should not be converted into food rich in protein and vitamin B, which are exactly what is required to rectify two major deficiencies in the diet of the masses. We are thinking at the moment in terms of waste molasses, but there is no reason to suppose that this is the only source of carbohydrate which will be sufficiently cheap for the purpose. Potatoes and some of our millets which yield well and of which these are in normal times surpluses in ceratin areas could likewise be used, but there are technical difficulties to be solved before this is possible. Provided food yeast can be profitably manufactured from molasses to start with, and the public can be educated to its use, it should be quite possible to extend production with the use of other crops. Food yeast production, if it succeeds in the early stages, may well follow the same course as many other fermentation industries, where the bye-product has become so important that it has eventually become the primary product.

Food yeast and yeast extracts may prove to be not only important nutritional aspects of fungi. Many edible fungi grow well under Indian conditions, *Volvaria diplasia* being one example. We have tended to regard fungi as of little importance nutritionally because of our disposition to regard the common English mushroom, *Psalliota campestris*, as the last word in edible fungi, although in many countries it is thought of as a second-rate edible form, and it is neither the most productive nor the simplest to cultivate. It is worth remembering that fungi are amongst the few organisms able to convert cellulose quickly into digestable carbohydrates.

The mycological problems of food yeast production (and they are many) will have to be worked out at factories, which will be located wherever there is a plentiful supply of molasses or other suitable carbohydrates. On the other hand, the cultivation of many fungi and the study of their nutritional value could be investigated quite well at a central place, and in practice is likely to remain a small-scale village industry. All stages of the research could well be done at a central agricultural institute.

Medicine

Originally important in medicine chiefly because of their poisonous nature, the value of fungi in pharmacy has been appreciated only during the past century in European countries, though doubtless going back many generations in China and other old civilizations. The production of the drug ergot, of which there is at present a world shortage, has received serious attention in South India, where it is being grown successfully on a commercial scale. Possibilities of the extension of ergot culture, the use of ergots indigenous to India, the risks involved in its culture, and possibilities of artificial culture, are matters deserving attention. Ergot production has to be done at places with a suitable climate, moderately humid and not excessively hot. The assaying and artificial culture can be done in any suitably equipped laboratories.

The most spectacular work in pharmacy in recent years has been the production of the drug, Penicillin. Its commercial production can now be exploited in well-equipped factories. There is much research work remaining to be done. The use of the drug for tropical diseases and the possibility of finding other drugs produced by fungi are specific problems to be worked on in well-equipped medical laboratories with the aid of skilled mycologists. It is the facilities for medical research which should be the criterian for selecting a suitable site for the work. A number of mycologists in India are investigating the problem, but there is some evidence to suggest that the objective

is not clear and that little more is being added to our knowledge than was already known from the work done in other countries. The best use is not, therefore, being made of the workers, who should be engaged on parts of the problem allotted to them by a co-ordinating authority.

Industrial Mycology

The mycology of fabrics, of foodstuffs, leather goods, plastics, insulating material, scientific equipment, and so on, has come to the fore especially during the war. It is a special branch of mycology requiring a thorough knowledge of the fungi commonly known as "moulds", a rather indefinite term covering certain Mucorales, some Ascomycetes such as *Aspergillus* and *Penicillium* and a large number of imperfect fungi of the Moniliaceæ and Dematiaceæ. While some of the work has to be done in factories and godowns, there seems to be no reason why, after the war, much of it should not be done in a central place which would have facilities better than could be provided by the numerous industries concerned acting individually. Such work could perhaps best be centred in one of the large manufacturing cities, and could be associated with a technological laboratory dealing with cotton, jute, or some other fibre.

Fundamental Mycology

All the aspects mentioned above have relation to specific major groups of problems. Each is connected with certain groups of fungi of a rather limited kind. In such work the danger is that the workers concerned will lose contact with other branches of mycology and will become narrow in their outlook, so that they will tend to overlook modern trends and remain unaware of the significance of findings by other branches which are of fundamental importance to their particular branch also. It is this narrowness of outlook, and its consequent limitation of scope and ideas, that has to be guarded against by giving proper attention to mycology itself, by which is meant the study of fungi for what they are themselves rather than for what is their importance to other sciences or to industry. A central research agency is required which can constantly have experts working on and monographing the various groups of fungi, recording their behaviour and their distribution in nature. Such an agency needs a particularly well-equipped library, first-class laboratories, a good herbarium and a national culture collection. The aim of the mycology section at the Imperial Agricultural Research Institute during recent years has been to build up such an organisation. It has meant a considerable change from the Pusa tradition which was built up, for obvious reasons, with an agricultural bias. Such a change in outlook was inevitable, for, as already pointed out, it could not deal with all, or even a major portion, of India's crop problems. Its facilities, however, are still inadequate, and a crying need is the establishment of a hill station where work can be carried out on the temperate fungi, many of which in all probability are carried yearly or occasionally to the hot plains during the cooler weather.

To summarise, we appear to need groups of mycological workers distributed more or less as follows:—

Plant Pathology: Agricultural experimental stations throughout India under the Government departments of Agriculture. *Soil Science*: Soil Science departments of the Universities. *Chemistry and Nutrition*: Factories, with a central laboratory for fundamental work attached to a nutrition laboratory. *Medicine*: A medical research institute. *Industrial Mycology*: In association with a technological laboratory dealing with fabrics. *Fundamental Mycology*: At a central research institute in association with other sciences and having access to a first-class library.

G. Watts Padwick.

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PROFESSOR P. C. MAHALANOBIS, F.R.S.

THE happy announcement of the election of Professor Prasanta Chandra Mahalanobis to the Fellowship of the Royal Society, will be received with supreme satisfaction by his numerous pupils, colleagues and admirers. The distinction is a belated recognition of his pioneering, substantial and enduring contributions to the science of Statistics, in its pure and applied aspects. The Indian Statistical Society and *Sankhya*, its official organ, owe their inception to his genius, zeal and organising ability. By example and by precept, he has inspired and fostered a strong, flourishing and an internationally recognised school of statistical science in this country. On this auspicious occasion, we wish to tender to the Professor our heartiest felicitations and wish him a long career of greater distinction and achievement.

RELATIVISTIC EQUATIONS FOR PARTICLES OF ARBITRARY SPIN

By H. J. BHABHA, F.R.S.

(Cosmic Ray Research Unit, Indian Institute of Science, Bangalore)

THE problem has often been formulated as to how far the equations for a relativistic particle of any assigned spin can be put into the form

$$(p_k a^k + \chi)\,\psi = 0 \qquad (1)$$

where $p_k = ih\dfrac{\partial}{\partial x^k}$, χ is some arbitrary constant and the a^k's are four matrices which satisfy a different set of commutation relations in each case. It is well known that the equation (1) is invariant for all transformations of the Lorentz group if the a's satisfy the commutation relations

$$[a^k, I^{rs}] \equiv a^k I^{rs} - I^{rs} a^k = g^{kr} a^s - g^{ks} a^r \qquad (2)$$

where the metric tensor g^{kr} is defined by $kg^{00} = -g^{11} = -g^{22} = -g^{33} = 1$, $g^{kl} = 0$, $l \neq k$ and the $I^{rs} = -I^{sr}$ are the six infinitesmal transformations of a particular representation of the Lorentz group satisfying the commutation rules

$$[I^{kl}, I^{rs}] = -g^{kr} I^{ls} + g^{ks} I^{lr} + g^{lr} I^{ks} - g^{ls} I^{kr} \qquad (3)$$

The further equation

$$[a^k, a^l] = I^{kl} \qquad (4)$$

can be shown to be consistent with (2) and (3) but it cannot in general be deduced from them. It should be noted that a possible numerical constant on the right of (4) can always be removed by absorption into the a's and results merely in a change of the value of χ in (1) which is without any significance.

I have investigated all possible equations of the form (1). It can be shown that these include a set equivalent to the one given by Dirac[1] and the alternative equivalent formulations in the force free case given by Fierz[2] for particles of any assigned spin. The necessary subsidiary conditions are not included. It also includes a set which is a generalisation to higher spins of the type of the scalar wave-equation. There are other more complicated sets. But I have proved that except for the case of spins 0, ½ and 1 equation (4) is not necessarily satisfied.

It can, however, be postulated that equation (4) shall hold for all spins. All the irreducible representations of the set of ten operators I^{kl} and a^k satisfying (2) to (4), i.e., all possible irreducible wave equations of the form (1) can then be found by the following artifice. We introduce a new index 4 and define

$$I^{k4} \equiv -I^{4k} \equiv a^k$$
$$g^{44} = -1, g^{k4} = 0 \quad k \neq 4 \qquad (5)$$

The equations (2) and (4) are then included in the set (3) if we let the indices in the latter run from 0 to 4 instead of from 0 to 3. But the resulting ten matrices I^{kl} then satisfy the commutation rules for the infinitesimal transformations of the Lorentz group in five dimensions, and all irreducible representations of these are known. The problem is, therefore, completely solved. It can also be deduced immediately that the four a^k's and the six original $^4I^{ij}$'s have the same eigenvalues (possibly multiplied by i to allow for the time-like character of the first co-ordinate). For example, by (2) and (3) the three quantities I^{kl}, a^k and a^l for $k,l = 1,2,3$ satisfy the three equations

$$[a^k, I^{kl}] = -a^l, \; [I^{kl}, a^l] = -a^k,$$
$$[a^l, a^k] = -I^{kl} \qquad (6)$$

which are just the commutation rules for the three components of angular momentum, and it follows from this that in any representation, irreducible or otherwise, I^{kl}, a^k and a^l have the same eigenvalues and satisfy the same characteristic equation. It can be proved further that for any irreducible representation the eigenvalues are always $s, s-1, \ldots\ldots -s+1, -s$ where s is any integer or half odd integer. One can define a particle of spin s as one for which the maximum eigenvalue of the I^{kl} is s. In that case more restricted commutation rules which the a^k's have to satisfy for a given value of s can be deduced from equations (2) to (4), as has been done by Madhava Rao[3] for $s = 3/2$ and $s = 2$.

The imposition of the condition (4) has very far-reaching consequences. It drastically cuts down the number of possible equations. The allowed set includes the Dirac equation and the scalar and vector Kemmer[4] equations, but it *excludes* the equations given by Dirac for particles of higher spin. The allowed equations for higher spins are such that each component of the wave-function in the force-free case does not satisfy the usual second order wave equation but a factorisable equation of higher order. To see this we note that since the a^k are matrices of a finite number of rows and columns, say n, the operator $P \equiv p_k a^k$ must satisfy a characteristic equation of order $\leqslant n^2$ whose coefficients can only contain products of the four quantities p_k multiplied by pure numbers. It can also be seen quite easily that this characteristic equation must be invariant for all transformations of the Lorentz group and hence must contain the p_k only in powers of the combination $p^2 \equiv p_k p^k$. To find the numerical coefficients we consider the special case when $P = p_0 a^0$, the other three components of p_k being zero. Since the eigenvalues of a^0 for spin s are $+s, \pm(s-1), \ldots$ it follows that the characteristic equation of P must be

$$\{P^2 - s^2p^2\}\{P^2 - (s-1)^2p^2\} \ldots\ldots = 0 \qquad (7)$$

the last factor being either P or $P^2 - p^2/4$ depending on whether s is an integer or half odd integer. Our derivation shows that this is the lowest order characteristic equation that P can satisfy, for otherwise a^0 would also satisfy one of lower order. Letting this equation act on ψ and replacing every P in it by $-\chi$ through a repeated use of (1) we see that each component of ψ must satisfy the equation

$$\{\chi^2 - s^2p^2\}\{\chi^2 - (s-1)^2p^2\}\cdots$$
$$\{\chi^2 - p^2\}\chi\psi = 0 \qquad (8a)$$

if s is an integer, or

$$\{\chi^2 - s^2p^2\}\{\chi^2 - (s-1)^2p^2\}\cdots$$
$$\{\chi^2 - {}^9/_4p^2\}\{\chi^2 - {}^1/_4p^2\}\psi = 0 \qquad (8b)$$

if s is half-odd integer. These equations show that a particle of spin s must necessarily appear with $2s$ and $2s+1$ values of the mass respectively, namely, $\pm\chi/s$, $\pm\chi/(s-1)$, ... Thus a particle of spin $^3/_2$ in this theory would necessarily be capable of appearing with two different values of the rest mass, the higher value being three times the lower. These higher values of the rest mass cannot be eliminated by an artifice any more than the states of negative mass (energy) in Dirac's theory of the electron, and we are, therefore, compelled to regard them as different states of the same particle. The above theory has the advantage over the theories of Dirac, Fierz and Pauli[5] that the equation (1) can be deduced naturally from a Lagrange function even in the presence of an electromagnetic field. There are no awkward subsidiary conditions.

1. Dirac, *Proc. Roy. Soc.*, A, 1936, **155**, 447–59. 2. Fierz, *Helv. Phys. Acta*, 1939, **12**, 3–37. 3. Madhava Rao, *Proc. Ind. Acad. Sci.*, A, 1942, **15**, 139–47. 4. Kemmer, *Proc. Roy. Soc.*, A, 1939, **173**, 91–116. 5. Fierz and Pauli, *Ibid.*, 1939, **173**, 211–32.

SCIENTIFIC RESEARCH AND INDUSTRY IN U.S.A.

By Sir J. C. GHOSH, D.Sc., F.N.I.
(*Director, Indian Institute of Science, Bangalore*)

THERE is an old Chinese saying that it is wiser to go abroad and learn than stay at home and teach. Accordingly we find that Chinese scholars for nearly a millennium, between the second century B.C. and eighth century A.D., came in large numbers to the famous universities of India, Taxila and Nalanda, staying there as long as they wished and seeing and learning whatever they wished to see and learn. The hazards of journey in those days were indescribable but where the spirit was daring, the flesh was never too week. The wheels of human progress move continuously and to-day have brought up to top the people of a country which only 300 years ago was a vast pathless jungle. We, from these ancient countries of India and China, cannot too often go to America and see for ourselves how the people there have shaped their lives and institutions which have enabled them to come to the forefront of progress. The Harvard University celebrated the ter-centenary of its foundation only few years ago. The Dean took us round what he called *the yard* of the University, round which the magnificent university buildings have been built. I asked him, "Why do you call it a yard and not a campus?" He said, it was the yard built by the Pilgrim Fathers with high walls all round, where they milked their cows and rested for night so that they might not be disturbed by ravenous wolves or red Indian poachers. The milk from the cows was fed straight to the children on the spot, and thus filled the need of a nursery school in the yard. That was the origin of the Harvard University. The few thousands of aboriginees there did not know that their problem of food and living could be solved in any way except by continuous wars of extermination between the tribes for small fields of maize or fishing grounds. Yet that country maintains to-day 150 millions of human beings with food, in such an excess that, some years ago, maize was burnt and milk thrown into streams to keep up the price level, with a standard of living so high that every family has a motor car of its own and perhaps two radio sets, one for the youngsters and the other for the elders, with one telephone for every eight persons, and with prophylactic and sanitary measures so perfect that the average expectation of life is sixty years. These have been achieved by the genius of the people in harnessing scientific knowledge for the development of the country. In Philadelphia, one cannot help admiring the statue of Benjamin Franklin on a long column which can be seen from miles; the central theme that he preached was that the most certain way of human betterment was improvement in natural knowledge. His countrymen have profited by this advice. They are making continuous efforts to learn the secrets of healthy living, to gain increased mastery over the force of nature, to make new materials having better qualities, to increase the productivity of the soil, and to improve the quality of crops and livestock by scientific breeding and management. All the Research Laboratories have one motto—"The impossible is only what we have not learned to do" and "what is impossible to-day will be commonplace tomorrow."

I believe it will be of more human interest if I were to touch lightly upon the activities of some of the institutions that we visited so that one may draw one's own conclusions regarding American enterprise in research. We visited, among other institutions in Washington —Bureau of Standards where the genial Dr. Lyman Briggs directs the activities of a magnificent group of workers. The average annual expenditure is about 3 million dollars. As a chemist, I was specially interested in the work of Rossini, who has practically revolutionised the technique of separation of hydrocarbons by fractional distillation. His long glass columns, often 60 feet high, give cuts whose boiling-points are constant within one-hundredth of a degree. Physico-chemical properties of these hydrocarbons were being studied with the greatest accuracy—their heats of combustion, free energies, specific heats, etc. This fundamental work is being undertaken because of a conviction in America that synthetic organic chemistry of the future will be based on the hydrocarbons of petroleum and natural gas. The Union Carbide and Carbon Corporation which has now absorbed the American Solvents Corporation, The American Cyanamide Company and the Bakelite Corporation, is now a giant chemical combine which has done pioneering work in this field, e.g., in the chlorination of hydrocarbons, in the preparation of vinyl and acrylic resins; in the

manufacture of polyethylene insulating films and sheets, in improvements in the manufacture of power alcohol from ethylene, etc. I was told that polyethylene films, because of their incredibly high dielectric strength, will be the insulating material in future electric machine construction and will make possible enormous reduction in the size of electrical machinery without affecting their H.P. The improved polyvinyl acetal resin is exceedingly strong and elastic; can be sandwiched between two sheets of glass without any other adhesive, requires no edge sealing, retains its elasticity at low temperatures with the result that any object striking the glass rebounds rather than penetrates. We were shown films impervious to air, and so strong that air-cushions made by enclosing air within two film surfaces and sealing off the edges by simple heating could easily carry our weights without bursting.

I was interested to find that even the Bureau of Standards under the stress of the war has become a manufacturing concern; the Indian Institute of Science is not the only culprit in this respect. They are the biggest producers of optical glass in U.S.A: in war time. Dr. Bates, the Head of the Glass and Ceramics Division, showed us all the details of manufacture and informed us that annual production now amounted to about 2 million dollars. I wish I were a glass technologist capable of taking a more intelligent interest in the details of the process with a view to their adoption in glass works in India. While talking of glass, I may mention that in addition to shrunk glass made by Corning Glass Works, which has the properties of quartz, there have been two notable developments in glass technology:—one is glass without silica, transparent tubes of which were shown us at the Carnegie Institute of Technology, Pittsburg, and the other, glass fibre with surprising properties, capable of being easily woven. Glass-fibre clothes are being extensively used in filtering strong acids—*e.g.*, it is the only material used in filtering TiO_2 from sulphuric acid mother-liquors. Very thin fibres are now available in many colours and as a non-inflammable and enduring fabric it is pushing its way in competition with linen and cotton for draperies and table covers, and in the electrical industry, as competitor against asbestos.

Another institution which we visited in Washington is the Headquarters Research Station in Bestville Farm of the Bureau of Agriculture. I was told of the work that was being done on nitrogen fertilisers. In all the belligerent countries, ammonium nitrate will be in excess supply after the war. It is a very good fertiliser but its water-absorption capacity stands in the way of its use. Waterproof bags, coating of the nitrate crystals with resins, are some of the lines of attack on which intensive work is being done. But the best work that has been done in U.S.A. is in the production and trial of urea as fertilisers. We in India now are using ammonium sulphate. The sulphate radical is not injurious in calcium-saturated soil, but increases the acidity of laterite soils, where its continued application is fraught with danger. Urea is much less acid-forming than ammonium sulphate and contrary to common belief, is as resistant to leaching as ammonium sulphate. Dr. Parker, the Chief Soil Chemist to the Bureau of Agriculture, is definitely of the opinion that urea is the nitrogen fertiliser of the future, specially in countries like India, which have no deposits of sulphur or gypsum near its coal fields. We were told that urea containing 44 per cent. nitrogen is now being manufactured by Dupont, about 200 tons a day at $5,000 a ton, i.e., at Rs. 165, whereas the anticipated cost of production of ammonium sulphate containing 21 per cent. nitrogen at a factory at Dupont, about 200 tons a day at $50 a Rs. 119 per ton. This excessive cost is due partly to freight charges of gypsum from Rajputana and Punjab fields to the coal fields of Bihar. Our agricultural planners envisage expansion of the ammonium sulphate industry to 2 million tons in 15 years; they will be well advised to plan the production of one million ton of urea instead.

From Washington we went to Pittsburg—the centre of America's Coal and Iron Industry—and were very cordially received by the authorities of the University and the many Research Institutions for which Pittsburg is justly famous. Closely associated with the University is the Carnegie Institute of Technology, which is very well equipped for purpose of teaching and research on metallurgy, ceramics and fuels. There are also in the neighbourhood, the laboratories for researches on coal maintained by the Bureau of Mines which is a department of the Federal Government. The biggest manufacturers of coke-oven-gas, and coke oven plant in U.S.A., Koppers, Ltd., have also their research laboratories there.

Then we have the Mellon Institute whose magnificent laboratories, built in 1937, set up a new standard even in America. This Institute was founded in 1911. The two brothers, Andrew and Richard Mellon, felt that their vast wealth could not be better used than by establishing a Research Institute which will help manufacturers who have little research facilities of their own, to develop new products or improve old processes. Such an Institute will be a strong force in the direction of improving the standard of living through discoveries and inventions. Then, out in the suburbs, are located the famous Westinghouse Research Laboratories which, in reputation, stands only second to the Research Laboratories of the General Electric Company at Schensctady. They have now in Condon one of the ablest physicists of the world to guide their research activities. And about fifteen miles from the city, are the laboratories of the Gulf Research Company where fundamental work is being done in geophysical methods of prospecting for oil, on lubricants and mechanical engineering problems associated with the use of liquid fuels and on the decomposition, polymerisation, isomerisation, cyclisation of paraffin hydrocarbons. The capital cost in building and equipment of each one of these laboratories is of the order of 7 to 10 million dollars, i.e., 2 to 3 crores of rupees, and the annual recurring expenditure is of the order of 2 to 5 million dollars, i.e., 75 to 150 lakhs of rupees. We often asked the question: Does it pay to spend such sums of money on research? We were told that an

industry that had been brought into existence with the aid of scientific knowledge could not hope to survive in a competitive world if not continually improved upon by new inventions. A forward looking executive always employs research to meet new competition, to avoid surprises which otherwise might seriously jeopardise his business and to prevent being placed at a great disadvantage should others come to know more about his business than he does himself. We were assured that research paid a handsome dividend, research sections are even more paying than actual operational sections. I am not able to speak with confidence about researches relating to an Electrical Industry, to metallurgy and geophysics in the Pittsburg area, but a few examples may interest you. We were shown a 5 million volt atom smasher of the electrostatic type which will be as powerful a tool for studies of nuclear physics as Cyclotron has been till now. We were shown the new device for producing powerful short-wave radio beams based on the properties of Magneton. We were also shown new and valuable alloys—one having the same coefficient of expansion as hard glass—covar, one possessing great strength at high temperatures which may be useful in high temperature gas turbine, a permanent magnet not more than six inches in diameter which I could not pull out from a steel joist. We admired a very rugged but an exceedingly sensitive instrument for measuring gravity within one part in ten million. Such an instrument can be placed in a lorry and accurate gravity surveys made of any area believed to be rich in mineral resources. I may give a practical illustration. On our way to England we rested for a night in the modern air port of Bahrein Island off the Coast of Arabia in the Persian Gulf. A few years ago it was only a fishing village inhabited by a few poverty-stricken Arab fishermen. I was told that it was included in the prospecting concession of the Anglo-Iranian Oil Company. The older methods of geological prospecting for oil by surface indication did not give much promise of a rich oil field below and the concession was surrendered. But the Americans came later on the scene and their newer geophysical methods predicted rich deposits of oil at great depths. It is well known that large salt deposits under the earth in the form of a dome are generally associated with deposits of mineral oil. Salt has a specific gravity which is less than that of sand and rock which form the earth's crust and its underground existence is often indicated by a diminution in the value of "*g*". There are other geophysical methods of confirmatory value, *e.g.*, records of seismic waves produced by detonating an explosive at the bottom of a deep hole reflected from various strata underneath, earth currents, etc. Their prediction proved true, and Bahrein Island is now a busy industrial centre producing and refining large quantities of petroleum and the Sheik of Bahrein is no longer a petty medieval landlord but an influential industrial magnate and I hope, a wise modern ruler. The 1,300 miles of air route from Bahrein to Cairo pass through the most inhospitable country of the world—North Saudi Arabia—with no sign of vegetable or animal life anywhere. But we were assured by the Director of the Gulf Research Laboratory that this desert highway will soon be a strategic highway of human civilization. They have discovered an oil-field there, 200 square miles in extent, which contains more oil than the two American Continents—every acre can have a well which will produce 10,000 barrels a day for 80 years. No hole has yet been drilled, but the oil is there as certain as the Sun rises in the East. Plans for building a long concrete channel to bring water from the Mespot rivers to this area are in progress and the survey of a pipe line which will link this field with Mediterranean on one side and Persian Gulf on the other has been completed. This field, now a part of the barren desert, will perhaps witness the rise of some of the richest cities in the world—air-conditioned factories, offices, and homes, with gardens all round. Similar garden-cities will also spring up at strategic points all along this pipe line through the desert. It will be one of the greatest triumphs of human skill and enterprise over adverse nature. Its influence on Indian economy is obvious. Cheap mineral oil will completely transform the methods of power production and furnace construction in the Western Coast of India which will be able to dispense with Bengal coal for such purposes.

One of the main problems of applied chemistry research in the Pittsburg area, relates to the devising of new instruments and apparatus which will place more powerful tools in the hands of industry. I found a team of physicists, physical chemists and mechanics engaged in designing and erecting a mass spectrograph which will give an automatic record of the relative proportion of the particles of different masses that may be present in the discharge chamber. I wondered what on earth would be the industrial advantage of such an instrument. I was told that the analysis in the field of gases that are obtained from different deposits when holes are drilled give valuable indication of the composition of rocks there, and any increase in the proportion of heavy hydrocarbon gases as the drill goes down is an indication of neighbourhood of oil deposits. Again, ordinary methods of hydrocarbon gas analysis which will give, say, the relative proportion of C_{10} and C_9 molecules are extremely difficult, inaccurate and time-consuming; and such an automatic mass spectrograph will do in three hours what thirty chemists might achieve in thirty days. The control of catalytic hydrocarbon reactions by analytical checks will be ensured by this remarkable instrumental development.

The chemical departments of the University and the Mellon Institute were largely absorbed in researches on synthetic rubber, resins, and plastics. They were mostly war secrets but I could gather that the investigators were studying the properties of polymerising and modifying agents with a view both to accelerate and control the process of polymerisation; they were also studying the possibility of manufacturing diamines and polybasic acids from petroleum hydrocarbons. Beneficiation of ores was another subject which was receiving considerable attention. The newer sink and float

method for concentration of ore is being applied for treatment of iron ore and coal.

But the two branches of research which overshadow every other activity here were researches on coal and petroleum hydrocarbons. One cannot help noticing the remarkable improvement in design of coke-oven plants by Koppers, Ltd. I saw their most up-to-date plant in New York which handles 1·5 million tons of coal per year, the ovens heated by an auxiliary producer gas system, labour-saving devices on the sealing of doors, careful heat balancing to such a nicety that the basement under the oven can be used for office work, handling of coke oven gas, benzene, toluene, naphthalene, anthracenes, tar, asphalt, by semi-automatic equipment with the result that about seventy men work in the factory starting from transference of coal from the ships to the disposal of final products. Mention may be made of researches on the identification of the primary constituents of coal, on Bergius process of coal tar hydrogenation, on complete gassification of low grade coals by treatment in retorts of special design and special corrosion-resistant material, on production of industrial chemicals like benzene, dicarboxylic and tricarboxylic acids by the oxidation of coal at low temperature and high pressure of oxygen in presence of alkali, on Fischer-Tropsch process using the modern fluid flow catalyst system, etc.

A solid catalyst used in a gaseous reaction often gets inactivated and requires to be regenerated. In industrial practice, we have two reactors containing the stationary solid beds of catalysts connected together by pipes and valves and so worked that, while the desired chemical reaction is being carried out in one reactor, the catalyst bed is being regenerated by suitable treatment in another. This discontinuous alternate process was a question mark to the research staff of the Standard Oil Company and after years of intensive work and by tying together all the work on powdered catalyst they hit upon the idea of keeping the pulverised solid catalyst always suspended in oil vapours, air or steam, as the case may be, and continuously moving it from where it did its catalytic work to where it was cleaned and back to the reactor by regulating at each point the pressure of the suspending gas phase and hence the speed of the catalyst particles. In May 1942, construction of a commercial plant on this basis was started and today 32 fluid catalyst plants are operating with a daily productive capacity of 300,000 barrels of 100 octane gasolene. The American Chemical Engineers predict that within a decade after the war very few chemical reactions will be permitted in industrial practice to take place on a stationary bed of solid material acting either as a reactor or as a catalyst. It will bring about a revolution in many types of chemical plant design.

I regret it will take hours if I were to talk about our visit to other cities and laboratories. American business executive are imbued with the idea that research is the *elixir of life* of an industry, ever keeping it young and vigorous. They think that it is ignoble parasitism to have to depend upon others for up-to-date technical knowledge. They recognise further that the advantage that comes to industry from scientific knowledge comes mostly from the early use of such knowledge and from contact with men who have created such knowledge. How different is the attitude from that of an average industrialist in India who thinks that all that is necessary for the industrialisation of India is to import from abroad plant and machinery and also technical talent for running such plants for, say, ten years and train up our men in the mean time to take the place of foreign experts. They forget that in these days of rapid progress their plant and process may become obsolete in ten years. I wish they may receive better advice and see more light.

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BIOLOGICAL REACTIONS: SPECIFIC, GROUP AND NON-SPECIFIC REACTIONS, AND THEIR SIGNIFICANCE IN EVOLUTION

By S. D. S. GREVAL

(Imperial Serologist's Laboratory, School of Tropical Medicine, Calcutta)

What They Are

A FOREIGN protein, ANTIGEN, introduced into a living animal otherwise than through the alimentary canal, PARENTERALLY, produces a substance, ANTIBODY, in the blood. The antibody reacts with the antigen in the test tube, *in vitro*, and in the living body, *in vivo*, in several ways. These reactions are called BIOLOGICAL REACTIONS. As the antibodies are found in the serum, the reactions are also called SEROLOGICAL REACTIONS. Further, as the reactions usually produce resistance or immunity in the body against the foreign proteins (usually the bodies of infecting micro-organisms), they are also called IMMUNOLOGICAL REACTIONS. Briefly, they are antigen-antibody reactions.

The easiest to perform and one of the most sensitive *in vitro* biological reaction is the PRECIPITIN REACTION. A soluble antigen injected into the body produces in the serum PRECIPITIN which produces a precipitate with the antigen. The potency, TITRE, of the precipitin (containing) ANTISERUM is measured by the highest (weakest) dilution of the antigen capable of causing a precipitate. It is usually of the order of thousands. The titre of the antisera used by the writer in detecting the source of blood in a bloodstain is of the order of 1 in 40,000, i.e., it is precipitated by a 1 in 40,000 dilution of the foreign serum. In such a dilution the protein cannot be detected by chemical tests. The biological reactions are, thus, seen to operate over a wider field than chemical reactions.

There are other *in vitro* reactions like COMPLEMENT FIXATION, exemplified by the well-known Wassermann reaction, which detect diseases in the system. This antigen-antibody reaction needs the intervention of

COMPLEMENT (a serological constituent, as opposed to a chemical constituent) which exists naturally in all fresh blood and *completes* the reaction.

NATURAL antibodies (as opposed to IMMUNE antibodies formed after injections) also exist. Bird's serum clumps, AGGLUTINATES, mammalian red blood corpuscles, rbc, by virtue of a natural AGGLUTININ.

Natural antibodies exist even against other members of the same species, ISOANTIBODIES. On such isoantibodies, ISO(HÆMAGGLUTI)NINS, depend the four blood groups previously discussed in this *Journal* (GREVAL, 1940).

Isoantibodies are also formed as a result of injecting bloods. The recently discovered Rh constituent of the human rbc is thus manifested (GREVAL, 1943).

In vivo biological reactions operate over still wider fields. In ANAPHYLAXIS the uterus of a guinea-pig previously injected with a foreign protein, SENSITISED, contracts in a 1 in 10 million solution of the foreign protein (McINTOSH, 1931).

Precipitin Reaction Taken as a Type

In this communication only the precipitin reaction will be considered. It was employed in a monumental work on the phylogenetic relationship of the mammalia (NUTTAL, 1904) and is employed to-day in tracing the origin of bloodstains in medicolegal work. The latter responsibility has probably made the study of this biological reaction by immunologists more critical than that of any other. It would pay biologists also to apply the present-day standardised techniques to the old problem again. It appears that a hundred per cent. biologist does not interest himself in biological reactions at all. Immunologists devise, refine and even apply them to his problems.

Specific Precipitin Reaction

Antihuman precipitin serum is prepared by (i) injecting a fowl intravenously with 3 c.c. of pooled normal human serum, (ii) bleeding the fowl to death under an anæsthetic ten days later and (iii) collecting the straw-coloured fluid from the clotted blood. All operations are performed with cleanliness and without pain. The antiserum is first tested for SENSITIVENESS: (i) a 1 in 1,000 dilution of normal human serum, when superimposed on the antiserum, should form at the junction of the two fluids a white ring *frank* in 2 minutes and *sharp* in 10 minutes; (ii) a 1 in 20,000 dilution should form a ring *dubious* in 10 minutes and *frank* in 20 minutes; (iii) a 1 in 40,000 dilution should form a ring which is dubious in 20 minutes. Then it is tested for SPECIFICITY: It should not react with a 1 in 1,000 dilution of normal sera from (i) buffalo, (ii) dog, (iii) horse and (iv) sheep and with a dilution of the order of 1 in 1,000 made from the dried blood of a monkey, in a stain of monkey's blood (by extracting the stain with normal saline and comparing its foam with that of 1 in 1,000 dilution of normal human serum). The sera passing the two tests are fit for use. They will detect the presence of human blood in the merest speck of blood.

Antisera for detecting the blood of animals are prepared and tested in the same way. The antiserum for testing the blood of a fowl is prepared in a rabbit which need not be bled to death. Its titre is not so high (1 in 1,000, 1 in 5,000 and 1 in 10,000 dilutions replace the other dilutions in the test for sensitiveness) and several injections may be required.

Group Specific Precipitin Reactions

1. *Human and monkey sera.*—Fresh monkey serum reacts with the antihuman serum almost like a human serum. On drying, its reaction is weakened rapidly. Of a dried stain of monkey's blood there is no risk whatsoever of being mistaken for a stain of human blood. The same observations apply to a reaction of human serum with an anti-monkey serum.
2. *Sheep and buffalo sera.*—When fresh they react almost alike with their antisera. Sheep serum and buffalo serum react with either antisheep or antibuffalo serum to the same degree. On drying the reaction weakens but not to the same extent as in the case of man and monkey. A distinction can only be made by timing of the appearance of the ring and by serial dilutions of the extract.
3. *Sheep and cow sera.*—The reaction is similar to the last reaction.
4. *Goat and buffalo sera.*—The reaction is similar to the last reaction.
5. *Goat and cow sera.*—The reaction is similar to the last reaction.
6. *Buffalo and cow sera.*—The distinction cannot be made with certainty.
7. *Sheep and goat sera.*—The distinction cannot be made with certainty.

The conclusion is obvious that in blood relationship man and monkey are more widely separated than sheep and buffalo/cow or goat and buffalo/cow, and much more widely separated than sheep and goat or buffalo and cow.

Non-Specific Precipitin Reactions

In the laboratory parlance when an antihuman serum fails in the test for specificity (begins to react with sera not used in its preparation and not coming from other animals in the same group) it is said to have turned polyvalent. It reacts with dog's serum for certain and with the sera of other unrelated animals occasionally. An opposite occurrence with respect to the anticanine serum was noticed many years ago: "It is worthy of note, that the tests made with the three preceding sera for carnivora (anticat, antihyæna, antidog—S.D.S.G.) agree in causing a larger proportion of reactions amongst the Primates than amongst any of the other mammalia, excepting the results with antihyæna serum which shows a large proportion of faint reactions amongst the Ungulates" (NUTTAL, *loc. cit.*). The question arises whether these reactions are indicative of a remote phylogenetic relationship and a diphylectic origin of the primates. Such an origin for the monkeys has been suggested on anatomical grounds alone (THOMSON, 1929).

The writer, further, finds that the antihorse serum also behaves like the antihuman serum in turning polyvalent and reacting with dog's serum. Of the opposite occurrence he has no

experience. The question, however, again arises whether the horse and the dog are more closely linked in blood than they appear to be on anatomical grounds.

Furthermore, the unconditional surrender of the dog and the horse to man may have a deep-seated biological basis. On the other hand, the irregularities in the formation of antibodies in response to the stimulus of a violent assault by a foreign protein on a living substance may be merely an outburst of vital potentialities, having no connection with the blood relationship whatsover. Such an outburst may be a vital feature and must have also occurred when *one* life born in abiogenes became *many* in biogenesis and laid the foundations of the phyla; after the first rain had fallen on the then newly cooled virgin rock and dissolving countless crystalloids had carried them downstream to make a sea; after the crystalloids during their mixture and interaction had produced colloids; after one of the colloids had found itself *alive*; in the remote past under physical conditions different from those prevailing now; when the newly born life was twisting, turning and undergoing variations very rapidly to establish itself and to ward off the attacks of the cosmic ray which also was young and more potent than it is to-day.

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MICROBIOLOGICAL ASSAY OF THE OVERALL POTENCY OF GROWTH-FACTORS OF SHARK LIVER EXTRACTS

BY

SORAB P. MISTRY, (MISS) INDIRA M. GAJJAR AND M. SREENIVASAYA

(Section of Fermentation Technology, Indian Institute of Science, Bangalore)

LIVER is reputed to constitute one of the richest sources of the B-complex, the anti-anæmic principles and other unidentified growth-factors. Williams *et al.*,[1] in their study of pantothenic acid, used liver as the starting material. Kuhn and Wieland[2] have shown that tunny fish liver contains the same active principles as those which characterise mammalian livers.

With the development of the shark liver oil industry in India, appreciable quantities of liver residues are, at the moment, available at various centres of the industry. It was, therefore, of interest to make a systematic study of this potentially useful bye-product, with special reference to its content of the B-complex. The present communication deals with a microbiological assay of the overall potency of the growth-factors of the liver extracts as revealed by the response potentiated by varying doses of the extract towards a strain of *Lactobacillus* (Culture No. 3, N.C.T.C.: 2078).

Research Material

The three commercially known varieties of sharks generally worked up for their oil were selected for the investigation. Table I gives data regarding the contents of their oil and its vitamin A value as determined by one of us (I. M. G.).

Table I

Zoological Name	Local Name	Oil content per cent.	Vit. A in I. U./gm.
1 *Carcharinus melanopterus*	Khada (K)	50·7	55600
2. *Galeocerdo tigrinus*	Waghbeer (W)	70·0	4700
3. *Carcharinus limbatus*	Pisori (P)	40·9	9700

Preparation of Extracts

The liver residue (100 gms.) in each case was treated with 100 ml. of water and the mash digested at pH 5·5 with activated papain (5 gms.) at 40° C. for 48 hours. The digest was filtered, pH of the filtrate adjusted to 4·5 with acetic acid, steamed for an hour and the precipitate filtered off. The pH of the filtrate was carefully readjusted to 7·0 with 10 per cent. sodium hydroxide. The extract was afterwards distributed into 10 ml. ampoules which after sealing were sterilised at 15 lbs. pressure for 20 minutes. In the case of the extract from sheep's liver, digestion with papain was preceded by autolysis at 30° C. for 48 hours. For comparison, Lily liver extract (I.U.S.P. unit/ml.) was employed as the standard.

Table II

Liver extract	Milligrams per milli litre of extract			Complexity
	Total solids	Total N	Amino N	
Lily (L)	151·0	15·6	3·24	4·81
Sheep (S)	330·0	28·6	9·12	3·13
Khada (K)	115·2	16·0	4·51	3·55
Waghbeer (W)	111·0	12·9	3·98	3·24
Pisori (P)	119·5	16·8	3·48	4·82

Selection of the Organism and the Preparation of the Inoculum

The organism (*Lactobacillus*, strain No. 3, N.C.T.C.: 2078) employed for the microbiological assay, was obtained from the National Collection of Type Culture, India, Indian Institute of Science, Bangalore. Consequent to a comprehensive study of the nutritional requirements of the lactic group of organisms in the National Collection, this strain was found to give the maximum response to most of the vitamins of the B-complex so far examined.

Stab cultures of the organisms were carried in liver extract.—Pentone, glucose, agar (3 ml. 100 ml., 0·5 per cent., 1 per cent., 1·5 per cent.). The method of preparing and carrying cultures were those described by Snell and Strong.[3]

Inoculum for assay tubes was prepared by transfer from the stock culture to a sterile tube of basal medium to which sheep liver extract was added (3 ml./100 c.c. of B.M.). The inoculum was incubated at 37° C. for 24-36 hours before use.

Basal Medium

A simple synthetic basal medium (B.M.) was selected and is a modification of that used by Snell and Strong,[3] for the determination of riboflavin, and by Pennington, Snell and Williams[4] for the determination of pantothenic acid. It contains acid-hydrolysed casein (vitamin and fat-free) 0·5 per cent., tryptophane 0·01 per cent., *l*-cystine 0·01 per cent., glucose 4·0 per cent., sodium acetate 2·4 per cent., and inorganic salts. The constituents are prepared and preserved as follows:—

Acid-Hydrolysed Casein.—50 Gms. of vitamin and fat-free casein (B.D.H.) were hydrolysed with 260 ml. of 25 per cent. H_2SO_4. The mixture was autoclaved for 10 hours at 15 lbs. SO_4-ions were removed with $Ba(OH)_2$ and any excess Ba-ion was carefully removed with the minimum amount of H_2SO_4. The solution was adjusted to contain 100 mg. of dry matter per ml. It was preserved under toluene. Traces of vitamins were effectively removed from the casein hydrolysate with 10 mg./ml. of 'Norit' at pH 3·0.

Tryptophane and Cystine.—Stock solutions of tryptophane and cystine hydrochloride containing 1 mg./ml. were prepared and kept under toluene.

Inorganic Salts.—Solution A contains 25 gms. of KH_2PO_4 and 25 gms. of K_2HPO_4 dissolved in 250 ml. of water.

Solution B contains 10 gms. of $MgSO_4.7H_2O$, 0·5 gm. of NaCl, 0·5 gm. of $FeSO_4.7H_2O$ dissolved in 250 ml. of water. Five drops of concentrated HCl were added to stabilise the solution. 0·5 Ml. of soltion A and 0·5 ml. of solution B contain the requisite inorganic salts for 100 c.c. of basal medium.

Assay Procedure

A medium having 2·5 times the concentration of the basal medium was prepared, pH adjusted to 6·8 and 2 ml. of this medium were transferred into each assay tube. Graded doses of liver extracts corresponding to 0·021, 0·42, 0·083, 0·208, 0·417, 0·625, 1·25, 1·875, 2·5, 3·0, 3·75 and 4·25 mg. of nitrogen were added and in each case, sufficient distilled water added to bring the final volume in each tube to 5 ml. Duplicates and a blank were run for each concentration. The tubes were sterilised at 10 lbs. for 30 minutes, twice at an interval of 24 hours. Three loops of the inoculum were inoculated into each assay tube and incubated at 37° C. for 72 hours. The acidity produced during this period was directly titrated against 0·1 N NaOH to pH 6·8-7·0 using bromthymol-blue as indicator. Results are given in Table III and are also graphically represented (Fig. 1).

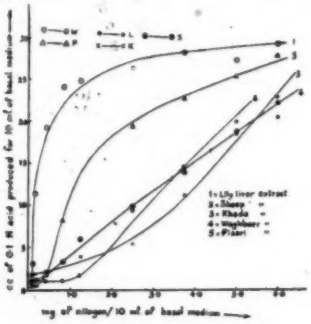

FIG. 1. Responses of N.C.T.C. 2078 to Liver Extracts

A close study of Table III and Figure 1 will reveal that, the Lily liver extract, per milligram of nitrogen potentiates the maximum response. Next in order comes the liver extract of Pisori, which, from the nature of the curve may be suspected to have a vitaminic make-up closely approximating to that possessed by the Lily liver extract. In other words, the functional similarity of the two extracts as revealed by the curves (see Fig. 1) suggests that Pisori liver might constitute a rich source of the antianæmic principles. The extracts from the livers like Khada and Waghbeer exhibit comparatively poor potencies; sheep's liver extract, however, gives a steady and linear response for the entire range of concentrations studied.

The minimal concentration of the extract (in terms of total nitrogen) at which the potency of the extract tends to get abolished is different for each of the extracts. These critical

TABLE III

Results expressed as ml. of 0·1 N acid produced for 10 ml. of basal medium

Liver Extract	Concentration of extract in mg. of nitrogen in 10 ml. of basal medium											
	0·042	0·083	0·125	0·167	0·417	0·834	1·250	2·500	3·750	5·00	6·00	7·50	8·50
Lily	1·1	1·1	3·1	11·3	19·3	24·1	24·7	26·3	28·0	27·2	29·0	32·1	34·3
Sheep	1·0	1·0	1·0	1·0	1·8	3·4	5·1	9·8	13·8	18·6	22·0	26·8	29·7
Khada	1·2	1·2	1·5	1·9	2·2	3·3	3·9	5·4	11·2	18·4	22·6	24·1	27·9
Waghbeer	1·1	1·1	1·1	1·1	1·1	1·1	1·8	9·4	14·5	19·9	20·3	22·5	29·7
Pisori	0·4	0·4	0·4	0·4	1·8	8·2	14·2	19·3	22·6	25·2	27·6	29·5	32·7

concentrations which are underlined in the table (Table III) represent the point below which the growth-factors, singly or severally, attain their respective limiting concentrations. It is interesting to observe that this limiting concentration is reached at the lowest nitrogen level (0·125 gms.) in the case of the Lily liver extract while in the case of Waghbeer liver extract the point is attained at a higher level of nitrogen (1,250 mgms.). The other extracts, including that of Pisori, exhibit loss of potency at a level of nitrogen corresponding to 0·417 milligrams.

It can also be noted that the response to the addition of the next higher concentration of the extract (higher than the critical concentration) is usually quick and substantial, particularly in the case of Lily and Pisori extracts.

The limiting concentrations of nitrogen may roughly be taken to be inversely proportional to the degree of purity of the extracts with respect to the growth-promoting factors. The potency and purity of the extracts may also be computed from the levels of nitrogen at which a given response is potentiated. For example, a response equivalent to about 10 ml. of decinormal alkali is given by 0·150 mgm. of Lily extract, 2·5 mgms. of sheep's, 3·7 mgms. of Khada's, 2·9 of Waghbeer's and 0·95 of Pisori's (computed from the curves, see Fig. 1). Taking Lily liver extract as containing 100 units of overall potency, the potencies for the extracts of sheep, Khada, Waghbeer and Pisori respectively work out as 6, 4, 5 and 16.

It has previously been suggested that the critical limiting value may have been reached with respect to a single or a multiple vitamin factor. With a view to elucidate this point, experiments were conducted, each of extracts being employed at the respective limiting level of nitrogen. Crystalline vitamins, thiamin, riboflavin, niacin, pyridoxine, calcium pantothenate and inositol were tried. Results are given in Table IV.

TABLE IV

Medium	Ml. of 0·1 N Acid produced for 10 ml. of B. M.		
	Khada	Waghbeer	Pisori
1. B. M. + L. E. + all vitamins	17·2	15·2	12·0
2. B. M. + L. E. + all vitamins except thiamin	15·7	14·1	11·0
3. B. M. + L. E. + all vitamins except riboflavin	8·4	14·0	10·6
4. B. M. + L. E. + all vitamins except Pyridoxin	17·4	15·5	10·6
5. B. M. + L. E. + all vitamins except Pantothenate	12·6	4·4	5·5
6. B. M. + L. E. + all vitamins except niacin	17·6	15·5	12·0
7. B. M. + L. E. + all vitamins except inositol	17·6	15·5	12·0

B.M. = Basal Medium; concentration of the vitamins used for each of the assay tubes was as follows:—Thiamin 0·5 γ; niacin 0·5 γ, calcium pantothenate 1 γ, riboflavin 1 γ, pyridoxine 0·5 mgm. Liver extract (L.E.) added = the limiting level of nitrogen as indicated in Table III.

Figures given in Table IV are highly significant; they suggest that the limiting concentration is reached mainly with respect to one of the vitamins. Khada lacks riboflavin mainly while pantothenic acid appears to be lacking in the liver extracts of Waghbeer and Pisori. The potencies of the extracts can, therefore, be effectively increased by the addition of the deficient vitamins.

SUMMARY

1. A comparative microbiological assay of the overall potency of the growth-factors of liver extracts, has been carried out using a strain of lactobacillus culture (N.C.T.C.: 2078), as the test organism. Three varieties of sharks, *Carcharinus melanopterus*, *Galeocerdo tigrinus*, *Carcharinus limbatus*, whose liver residues constitute a useful bye-product of the shark liver oil industry, have been investigated.

2. *Carcharinus limbatus* has been found to yield the most potent extract with a functional similarity approximating to the standard Lily liver extract.

3. Shark livers with high contents of the fat-soluble vitamins appear to constitute poor sources of the water-soluble B-complex. The two groups of vitamins appear to occur together in the inverse ratio (see Table I).

4. Recent clinical reports suggest that the antianæmic factors (extrinsic) are identifiable with some of the important members of the B-complex. Further, recent studies have shown that the B-vitamins are essential for the synthesis of hæmoglobin and the formation of corpuscles. These observations are significant in relation to the functional behaviour of the Pisori liver extract and suggest that it might prove a good source of the antianæmic factors.

5. The response of the various extracts at their limiting concentrations to the addition of specific vitamin shows that some of the vitamins are lacking in them; the addition should serve to render the extract physiologically more balanced and potent.

Our grateful thanks are due to Sir J. C. Ghosh for his kind interest in these studies.

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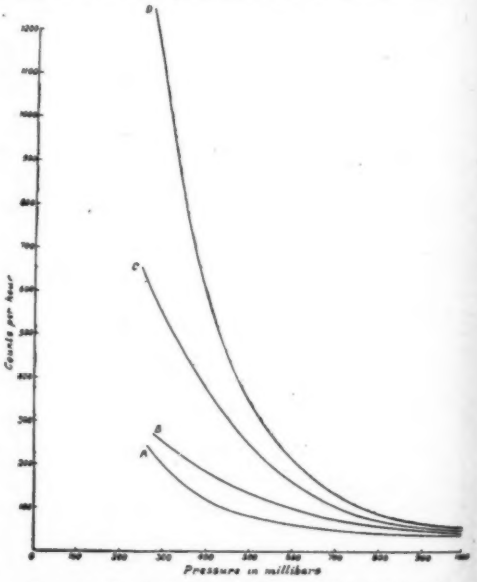
LATITUDE EFFECT FOR MESONS

Schein, Jesse and Wollan,[1,2] and Schein, Jesse and Grötzinger[3] have measured the variation with altitude of the vertical intensity of mesons penetrating 10 cms. of lead at Chicago, magnetic latitude 52·5° N. Similar measurements were made earlier by Dymond[4] at Edinburgh, magnetic latitude 59° N, but the work was interrupted by the war and only a preliminary note has been published. No such measurements have yet been made near the geomagnetic equator. We have, therefore, measured in an airplane the vertical intensity of mesons penetrating a 20 cms. block of lead absorber at Bangalore, magnetic latitude 3·3° N, up to a height corresponding to a pressure of 275 millibars 32,000 ft., with a quadruple coincidence counter telescope in which the extreme counters were 35 cms. apart. The counters were 15 cms. long and 3½ cms. in diameter. The geometry of the telescope was, therefore, such that a particle recorded at the maximum allowed angle of 22° would travel a thickness of the atmosphere and absorber only 8 per cent. greater than a particle arriving vertically.

In the figure we have plotted our results giving the intensity of mesons penetrating 20 cms. of lead at 3·3° N as curve A and, for comparison, the latest results of Schein, Jesse and Wollan[2] for the intensity of mesons at 52·5° N as curve B. The two curves have been fitted at sea-level to allow for the known latitude and longitude effect[5] of 12 per cent. In the same figure we have plotted the variation of the total vertical intensity with altitude at 3·3° N as given by Neher and Pickering[6] for a triple coincidence counter telescope as curve C, this curve being fitted to our curve so as to show a ratio of vertical meson intensity to total vertical intensity of 80 per cent. as observed at ground-level at Bangalore. Curve D gives the variation of the total vertical intensity with altitude as measured by Pfotzer[7] at a magnetic latitude of 49° N. The four curves together show at a glance the striking fact that whereas the latitude effect between 3·3° N and 49° N of the total intensity shows a pronounced increase with altitude, the penetrating component shows practically no such increase of latitude effect even to heights corresponding to a pressure of 275 millibars. Our results give at least qualitative support to the theory of Hamilton, Heitler and Peng[8] according to which the penetrating component



Curve A—Vertical meson intensity at 3·3° N (Bhabha, Aiya, Hoteko and Saxena). *Curve B*—Vertical meson intensity at 52·5° N (Schein, Jesse and Wollan 1941). *Curve C*—Vertical total intensity at 3·3° N (Neher and Pickering). *Curve D*—Vertical total intensity at 49° N (Pfotzer).

should show only a slightly greater latitude effect than at sea-level up to the heights corresponding to a pressure of 100 millibars. The difference in the geometry of the counter telescopes used by the different authors and the statistical accuracy of the results do not yet permit a quantitative comparison.

A detailed report of this work together with other results will be published shortly elsewhere.

It is with pleasure that we express our gratitude to Col. M. C. Robinson, Commanding Officer of the 84th Air Depot of the U.S.A. Air Force, for giving the permission for the flight, and also to Major G. Denis, Capt. J. Claunch, Lt. Mack, and Sgt. Beaver, under him, for their whole-hearted co-operation.

H. J. Bhabha.
S. V. Chandrashekhar Aiya.
H. E. Hoteko.
R. C. Saxena.
Cosmic Ray Research Unit,
Indian Institute of Science,
Bangalore,
April 10, 1945.

1. Schein, Jesse and Wollan, *Phys. Rev.*, 1940, **57**, 847. 2. —, —, —, *Ibid.*, 1941, **59**, 615. 3. —, — and Grötzinger, *Ibid.*, 1940, **58**, 1027. 4. Dymond, *Nature*, 1939, **144**, 782. 5. Millikan, Neher and Pickering, *Phys. Rev.*, 1942, **61**, 397. 6. Neher and Pickering, *Ibid.*, 1942, **61**, 407. 7. Pfotzer, *Zeits. f. Physik*, 1936, **23**, 102. 8. Hamilton, Heitler and Peng, *Phys. Rev.*, 1943, **64**, 78.

EFFECT OF THE RATE OF TRICKLE ON THE MASS OF THE DROP

In determining the surface tension of a liquid by the drop weight method it is necessary that the drops should be formed sufficiently slowly so that the conditions at the time of separation of each drop from the nozzle of the tube are truly static or very nearly so. The rate of formation of drops in Lord Rayleigh's[1] experiments was about a drop per minute, while Edser[2] and Worsnop and Flint[3] recommend a rate even as high as 60 drops per minute. An interesting point was revealed when actually an experiment was performed to bring out the effect of the rate of trickle on the mass of the drops formed. The results (Fig. 1) show that for small rates of trickle, the mass of the drop increases very slowly, but for larger rates it increases very rapidly to large values when the discrete drops are about to merge into a continuous jet.

A drop separates from the main bulk of the liquid at the nozzle when its weight just exceeds the pull due to Surface Tension. With increasing rate of trickle the liquid rushes out with an acceleration; this effectively reduces the weight of the drop and the drop grows to larger dimensions till the effective weight pulls it down. According to Lord Rayleigh for static conditions (*i.e.*, rate of trickle $n = 0$) $m_0 g = 3{\cdot}8\,rT$ where m_0 is the weight of the drop when $n = 0$; r is the external radius of the capillary orifice and T is the surface tension of the liquid. If "a" represents the equivalent acceleration of the liquid when the rate of

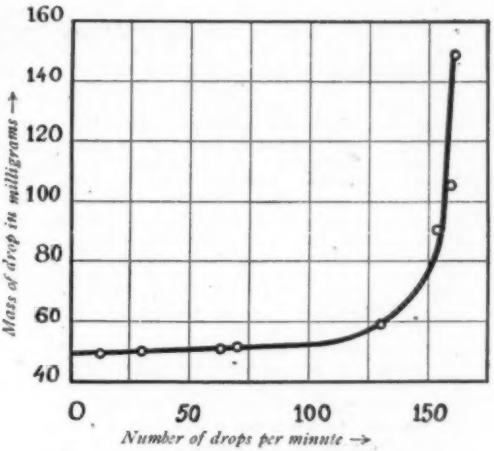


FIG. 1. Variation of the mass of drop with the rate of trickle

trickle is n drops per minute and m is the corresponding mass of the drop, we may write

$$m(g - a) = 3{\cdot}8\,rT = m_0 g \quad \therefore m\left(1 - \frac{a}{g}\right) = m.$$

Now the acceleration "a" depends on "n" the rate of trickle. Therefore we write $m[1 - f(n)] = m_0$ where $f(n) = 0$, when $n = 0$. Since the experimental curve is nearly a rectangular hyperbola $f(n)$ probably has the form kn^x where k and x are constants.

In order to confirm the above explanation qualitatively experiments were carried out using strong electric fields to aid the acceleration of gravity. The drops actually separate out at an earlier stage of growth than when such an aiding force is absent.

Department of Physics,
Nowrosjee Wadia College,
Poona 1, V. N. Kelkar.
January 15, 1945.

1. Lord Rayleigh, "Investigations in Capillarity," *Phil. Mag.*, 1899, **48**, 321-37. 2. Edwin Edser, *General Physics for Students*, p. 319. 3. Worshop and Flint, *Advanced Practical Physics for Students*, 2nd Edition, p. 128.

OCCURRENCE OF FLUORSPAR NEAR MALHAN, JUBBALPUR DT., C.P.

This note reports the occurrence of a workable deposit of fluorite near Malhan (N. 80° 31′; E. 23° 40′), in the Jubbalpur District, C.P. The place is about 7 miles S.W. of Rupaund Railway Station on the Katni-Bilaspur branch of B.N.R. The country rock consists of dolomite with intercalations of slate and chlorite schists of Dharwar age. The strike varies from E.-W. to N.W.-S.E. and the dip is northwards varying from 30° to 90°. The dolomite is often found to be intruded by quartz veins which vary in width from 4′ to ½″. There are also basic dyke rocks intruded into the country rock.

Fluorite occurs only in pockets in the dolomite. There are no regular veins or zones which can be traced for some distance. Galena, chalcopyrites, malachite, barytes and calcite are associated. Quartz veins are found quite close to most of the fluorite-bearing pockets. The fluorite of this area is usually pink, but colourless and blue varieties are also present. This colour disappears on heating the mineral. These different varieties of fluorite were tested for fluorescence under ultra-violet light from a mercury vapour lamp. Except one blue variety which showed slight blue fluorescence, the others were non-fluorescent. It was observed, however, that pink fluorite after being decolourized on heating, gives a fairly strong fluorescence when placed in ultra-violet light.

The country close to the lode and the vein materials do not apparently show any sign of shearing in the field but a definite indication of shearing of the minerals has been detected under the microscope. The country rock has been successively replaced by barytes, mica, metalliferous ore-minerals, fluorite and quartz. It is probable that shearing action took place when the ore-minerals were being deposited or before their deposition was complete, that is to say, before the beginning of the fluorite deposition. This is very easily noticed under the microscope, as there is no trace of any shearing phenomena in the fluorite mineral, of the region. The sulphide minerals usually occur as irregular masses scattered at random from the walls to the centre of the pockets. Barytes is a common gangue mineral present in almost all the veins. In some of the fluorite bearing pockets baryte and fluorite form alternating bands and some of the barytes lumps show a coating of fluorite on the surface. Argentiferous galena occurring along the fluorite-bearing pockets is considered as indication of the magmatic origin of the mineralizing materials in this region. Crystallisation of fluorspar is undoubtedly the pneumatolitic phase of the mineralizing magma.

Four prospecting trenches ($30' \times 12' \times 10'$) have been dug in this area. Out of these four, two are producing galena, and fluorite and one of them contains copper-ore also. The third one produces argentiferous galena and copper ores (melachite and traces of primary sulphide). The fourth one yields melachite incrustations along with the other gangue minerals. In all the trenches the trend of deposits are found to run N.N.W.-S.S.E. In the first trench the galena and fluorite-producing zone is about 3', out of which the western portion produces fluorspar only. Fluorite produced from this pit is generally medium-grained and pink in colour. The yield of fluorite is 20 to 25 per cent. of the rock-body that has been excavated. The second trench produces also fluorite, the pit has been dug about 10' away from the first one along the line of the strike of the lode. The quality produced is good and comparatively bigger crystals are found. The fluorite-producing zone is about 1½ to 2' wide. The percentage of fluorite in the rock-body is about 25 to 30 per cent. of the rock excavated. Hand-picking by breaking the lump rock raised the percentage to nearly 50 per cent. and it is expected that crushing and washing would increase the concentration of fluorite upto a minimum commercial specification. A more elaborate milling with figs. and tables followed by a suitable flotation-concentration operation, might further increase the percentage of fluorite to a very high degree. As regards the quantity of material available in this area, it is difficult to say anything definitely at this stage, a further detail prospecting work would prove ore reserve.

Geological Laboratory,
Post-Graduate Science Dept., S. DEB.
Calcutta University, S. K. ROY.
January 10, 1945.

OCCURRENCE OF GARNETIFEROUS LEPTYNITE AT MEENAKSHNIPURAM, COCHIN STATE

LATE Mr. K. K. Sen Gupta, in his 1911 report on the Geology of Cochin State, described two garnet-bearing rocks, one along the tramway line between Mudavarichal and Oorukumbankutty and the other at Pothupara. "The rocks of South Travancore are conspicuous by the abundance of garnets present in them, those of North Travancore and Cochin hardly growing any. Sir Thomas Holland discusses the origin and growth of garnets from pyroxenes and their micropegmatite intergrowths in pyroxenic rocks of South India. The total absence of garnetiferous rocks in the State except two exposures, makes it extremely difficult to verify his conclusion."

We have recently found a big quarry of garnetiferous leptynite on the northern side of the road at the western extremity of Meenakshipuram village in Chittur Taluk. This rock exactly resembles the garnetiferous leptynite of South Travancore. It is leucocratic and consists of quartz, felspar and garnet with biotite and magnetite as accessory minerals. The garnet occurs as reddish-brown grains and patches and belongs to the variety, grossularite.

This discovery proves that this rock is not confined to South Travancore. The relations of this rock with the other rocks of the area are being studied.

Ernakulam, T. SUDHAKARA MENON.
February 7, 1945.

ASSAY OF THE GROWTH-PROMOTING ACTIVITY OF THE "FATS" ASSOCIATED WITH SOME CEREALS

IT has been shown[1,2,3] that the larvæ of the rice moth (*Corcyra cephalonica* Staint) can be employed as a test animal for the biological assay of fat-soluble factors. It was of interest to make a comparative study of the growth-promoting potency of "Fats" from cereals obtained by solvent extraction. Chloroform-extracted jowar constituted the basal diet from which the "whole" diets were reconstituted by enriching the flour with the fat from each of the cereals to the extent of 4·28 per cent.,—this being the percentage of "fat" in jowar.

A further comparison of the fats of the cereals was made with a sample of shark liver oil.

Results are tabulated below:—

TABLE I

Diet	Average weightof 10 larvæ in mgm. after					Survivals
	0 days	8 days	14 days	21 days	Pupation at 21 days	
I	9·08	141·90	352·58	All pupated	All pupated	12 out of 12
II	9·28	16·38	16·82	13·04	No pupæ	4 ,, 12

Diet I—Whole jowar. Diet II—Chloroform extracted jowar.

TABLE II

Diet	Average weight of 10 larvæ in mgm. after					Survivals
	0 days	8 days	14 days	21 days	Pupation at 21 days	
I	4·82	63·76	173·60	290·72	2 larvæ, 10 pupæ	12 out of 14
II	4·84	46·30	151·44	226·46	2 pupæ, 12 larvæ	14 ,, 14
III	4·50	46·86	116·86	181·26	No pupæ	14 ,, 14
IV	4·64	25·88	68·26	122·98	,,	12 ,, 16

Diet I—Chloroform extracted jowar + Wheat fat (4·28%). Diet II—Chloroform extracted jowar + Ragi fat (4·28%). Diet III—Chloroform extracted jowar + Jowar fat (4·28%). Diet IV—Chloroform extracted jowar + Fish oil (4·28%).

TABLE III

Diet	Average weight of 10 larvæ in mgm. after					Survivals
	0 days	13 days	19 days	26 days	Pupation at 26 days	
I (*a*)	3·54	62·92	..	All pupated	All pupated	16 out of 16
(*b*)	5·82	165·92	386·46	,,	,,	16 ,, 16
II (*a*)	3·88	64·60	146·08	241·02	2 pupæ, 14 larvæ	16 ,, 16
(*b*)	5·90	91·34	175·02	270·62	8 larvæ, 6 pupæ	14 ,, 16
III (*a*)	3·98	53·68	121·46	..	2 pupæ, 12 larvæ	14 ,, 16
(*b*)	7·16	91·52	156·88	..	..	..
IV (*a*)	4·14	47·52	114·56	233·82	2 pupæ, 10 larvæ	12 ,, 16
(*b*)	6·02	91·74	150·12	156·50	8 pupæ, 4 larvæ	12 ,, 16
V (*a*)	4·24	35·12	56·58	100·02	No pupæ	14 ,, 16
(*b*)	6·06	46·32	78·72	134·66	,,	16 ,, 16

Diet I—Whole jowar. Diet II—Chloroform extracted jowar + Wheat fat (4·28%). Diet III—Chloroform extracted jowar + Ragi fat (4·28%). Diet IV—Chloroform extracted jowar + Jowar fat (4·28%). Diet V—Chloroform extracted jowar + Fish oil (4·28%).

TABLE IV

Diet	Average weight of 10 larvæ in mgm. after			Survivals
	0 days	7 days	14 days	
I	6·48	44·66	196·90	16 out of 16
II (*a*)	7·04	45·12	164·52	16 ,, 16
(*b*)	8·37	60·42	192·98	11 ,, 12
III (*a*)	6·84	41·76	156·16	14 ,, 16
(*b*)	8·25	58·69	179·46	11 ,, 12

Diet I—Whole jowar. Diet II—Chloroform extracted jowar + Ragi fat (4·28%). Diet III—Chloroform extracted jowar + Jowar fat (4·28%).

Results given in Table I show that the chloroform-extracted jowar, constituted a reasonably good basal diet for the studies in question; extraction with the chloroform deprives the cereal practically completely of its fat-soluble growth-promoting factors. It will be observed (see Table I) that the reconstituted diet (chloroform-extracted jowar with an equivalent quantity of the chloroform extract) does not restore completely the full potency inherent to the whole jowar. This is possibly due to the fact that during the process of solvent etraction, the essential factors are partially destroyed or inactivated by heat or oxidation.

A study of results given in Tables II, III and IV reveals:—(1) Of the "Fats" investigated, the one from wheat exhibits the highest potency, not only from the point of view of the rapidity of growth but also from the standpoint of the percentages of the survivals and the pupations. (2) Ragi "fat" shows a slightly higher potency than jowar "fat". (3) Ramaswamy *et al.*[4] observed that ragi does not support the growth of the larvæ as well as jowar; they attribute this fact to the lower "fat" content of ragi. But our experiments show that the "quality" of the "ragi fat" is slightly higher than that from jowar. (4) The fish oil exhibits the lowest potency.

The experiments show that the larvæ can be conveniently employed for the assay of the potency of "fats"; it is proposed to extend this method for the biological assay of the growth-promoting potency of the "fat" from several strains of yeasts.

(Miss) Violet de Souza.
M. Sreenivasaya.
Section of Fermentation Technology,
Indian Institute of Science,
Bangalore,
February 14, 1945.

1. Sarma, P. S., and Sreenivasaya, M., *Curr. Sci.*, 1939, **8**, 551. 2. —, —, *Ibid.*, 1941, **10**, 525. 3. De Souza, V., and Sreenivasaya, M., *Ibid.*, 1944, **13**, 250. 4. Ramaswamy, S., *et al.*, *Ibid.*, 1942, **11**, 53.

A SIMPLE MICRO-MACERATOR FOR PLANT ANALYSIS

Special importance is attached by the plant analyst to the primary operation of grinning the experimental material and bring ing it into a condition which facilitates the quantitative extraction of the constituent to be estimated. The available methods of treatment[1,2,3,1] are unsuitable either because the technique is tedious or because it involves the use of expensive or fragile equipment. An inexpensive, efficient and elegant micro-macerator has been developed, and comparison with the earlier methods and repeated tests with different types of plant tissues have established its suitability and efficiency.

The essential features of the apparatus are illustrated in Fig. 1. The lower portion is made from a thick-walled pyrex tube. The upper end of the tube is blown out in the shape of a thistle funnel with a spout. The lower end of the stopper is ground into the slightly tapered (shaded) portion of the tube by using emery powder and water.

Fig. 1

Procedure.—0·1-0·2 gm. of plant material is weighed out accurately into a tube, moistened with 2-3 ml. of the extractant poured in driblets into the cup of the macerator formed by fixing the stopper to the tube, and ground down to a paste which will gradually creep down the joint into the tube. The pasty mass is transferred to the flask of a micro-extraction apparatus and the tube, the cup and the stopper of the macerator are rinsed 3 or 4 times with fresh quantities of the extractant to facilitate the transfer of all the material to the extraction apparatus. Often it is necessary to rub the last traces of the material with the

pointed end of the stopper. About 10-15 minutes are required to crush 0·1-0·2 gm. of plant material. The material is now ready for the next operation.

Micro-Estimation of Starch.—The plant material used in the experiments was previously extracted with 80 per cent. alcohol, dried at 100° C., and then powdered to pass through a 100-mesh sieve. Duplicate aliquots of the material were weighed out for extraction by the present method. For comparing, the estimation was carried out by the earlier method of the author.[1] The macerated samples were extracted on a boiling water-bath with about 7-10 ml. of 0·7 per cent. KOH solution for 30 minutes with occasional stirring with a glass rod. The mixture was then centrifuged for 5 minutes (2,000 r.p.m.) and the extract transferred to a clean tube. A fresh quantity of the reagent (5 ml.) was added to the plant material and again extracted for 10 minutes. After centrifuging, a test portion of the second extract was tested for starch. In the majority of cases the first extraction removed all the starch from the plant material. Second extraction was necessary only in some cases where the concentration of starch was very high. The starch extract was concentrated, filtered, filter-paper washed 2 or 3 times with distilled water and finally made to volume (25 ml.). Aliquots of the solution were taken for the estimation of starch by the micro-iodine method.[2] Results are presented in Table I.

The results clearly show that the time taken for the complete removal of starch by the present method is considerably less than that required by the earlier technique.

The micro-photographs presented in Figs. 2 and 3 clearly demonstrate the efficiency of the micro-macerator. Fig. 2 shows an iodine-stained ground (100-mesh) stem tissue, and Fig. 3 the same material after passing through the micro-macerator and staining with iodine.

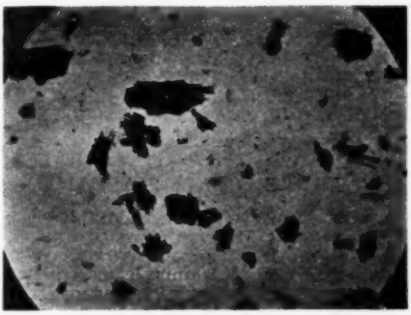


FIG. 2. A sample of stem passed through 100-mesh sieve

FIG. 3. The same sample of stem (Fig. 2) ground in the micro-macerator

TABLE I

Comparison of methods for starch extraction

Plant material	Sand-tituration method (1938)				Present method			
	Sample analysed (g.)	No. of extractions	Time of extraction (minute)	Starch Per cent. dry wt.	Sample analysed (g.)	No. of extractions	Time of extraction (minute)	Starch Per cent. dry weight
Leaf — S. 1	0·1180	4	120	5·19	0·1030	1	45	5·03
Leaf — S. 1	0·2857	5	140	4·95	0·2240	1	45	5·22
Leaf — S. 2	0·2011	5	140	6·17	0·1980	1	45	6·04
Leaf — S. 2	0·2430	5	140	5·78	0·3841	2	60	6·04
Stem — S. 3	0·1270	4	120	9·28	0·1352	1	45	9·61
Stem — S. 3	0·2812	5	140	8·62	0·3100	1	45	8·93
Stem — S. 4	0·1740	5	140	6·89	0·1811	1	45	6·49
Stem — S. 4	0·2241	5	140	6·31	0·3450	2	60	6·76

Imperial Agric. Res. Institute,
New Delhi,
January 23, 1945. J. J. CHINOY.

1. Chinoy, J. J., *Analyst*, 1938, **63**, 876. 2. —, *Indian J. Agri. Sci.*, 1941, **11**, 95. 3. Hanks, J. H., *Science*, 1941, **94**, 615. 4. Rask, O. S., *J. Assoc. Off. Agri. Chem.*, 1935, **18**, 502.

MODE OF OCCURRENCE OF VITAMIN A IN SHARK LIVERS

WALD,[1,2] and Hecht, Chase, Shaler and Haig[3], have shown that vitamin A occurs in combination with protein in visual purple of the eye and plays an important rôle in the photochemical reactions accompanying the visual process. Lovern, Edisbury and Morton[4] have shown that on the extraction of oil from livers by non-polar solvents—to avoid denaturation of proteins—vitamin A may still be present partly in combination with protein and partly in oil solution. Working on the distribution of vitamins A_1 and A_2 in different coats of the intestinal tube, Lovern and Morton[5] concluded that the vitamin-protein complex may influence the transport of fatty acids from the intestines. Indirect evidence that vitamin A may partly occur as an integral part of liver tissue, has been observed during a comparative study of the processes of extraction of oil from shark livers. Shark liver containing 60 per cent. or more of oil was found to yield to the pressure exerted by its own weight a considerable quantity of oil on its keeping for a very short time after the removal of the liver from the shark. Two such individual samples of whole livers were selected for the experiments. The oil which oozed out was skimmed off and the liver treated with high pressure steam in specially fabricated steaming vats to extract the rest of the oil. The vitamin A potencies and a few chemical and physical characteristics of these fractions were then determined and compared. Vitamin A potency was assayed on the whole oil by the Carr-Price reaction using a B.D.H. pattern Lovibond Tintometer. The oil data were obtained by methods described before.[6]

Comparative data are presented in the table given below:—

TABLE I

Comparison of the two oils

Particulars	Sample I		Sample II	
Weight of liver	87 lbs.		82 lbs.	
Total weight of oil	62 lbs.		60 lbs.	
Percentage yield	71·3		74·5	
Sample of oil	Oozed out	Steam extracted	Oozed out	Steam extracted
Vitamin A potency Carr-Price Value	33·2	84·9	c. 1·0	16·9
Colour	Yellow	Orange	Yellow	Orange
Refractive Index, 35° C.	1·4623	1·4635	1·4653	1·4659
Acid Value, mgm. KOH/gm.	0·45	1·1	0·5	2·6
Saponification Value	154·4	155·6	168·6	172·0
Iodine Value: Wijs	78·54	83·71	102·3	100·2

The table shows that vitamin A does not occur wholly in oil solution in shark livers; It appears to be partly present as a complex with protein. This has some bearing on the conditions to be adopted during any oil extraction process.

Thanks are due to the Director of Industries and Commerce, Madras, for permission to publish this note.

Technical Research Lab.,
Govt. Oil Factory,
Calicut, ULLAL SUNDAR KINI.
January 12, 1945.

1. Wald, *J. Gen. Physiol.*, **1935**, **18**, 905. 2. —, *Ibid.*, **1938**, **19**, 35. 3. Hecht, Chase, Shaler and Haig, *Science*, **1936**, **84**, 331. 4. Lovern, Edisbury, and Morton, *Nature* (London), **1937**, **140**, 276. 5. Lovern and Morton, *Biochem. J.*, **1939**, **33**, 330. 6. Kini, U.S., *J. Ind. Chem. Soc., Indr. and News Edn.*, **1944**, **7**, 1, 32.

PYRETHRUM IN KASHMIR

PYRETHRUM has received considerable attention in India during recent years. Among the Provinces and Indian States who have taken up its cultivation, Kashmir leads with nearly 1,500 acres of land under Pyrethrum. A comparative study has been made of the pyrethrin content of the flower-heads collected from plantations situated at different altitudes during the past two years, to establish the optimum conditions for its collection, cultivation and drying under the local conditions. A large number of samples were collected from each individual plantation at different stages of blossoming of the flower-heads and assayed in this laboratory.

Results (Table I) indicate that the pyrethrin content tends to increase from the closed to the opened stage, but when the flowers are fully opened this percentage shows a decrease. This is obviously caused by the increase in the weight of the flower-heads which follows pollination and the subsequent formation of seed. This latter growth results in an increase of nearly 60 per cent. in the weight of flower-heads. Table I below details the results summarised above.

TABLE I

S. No.	Locality	Altitude (feet above sea-level)	Average weight of individual flower	State of Maturity	Total Pyrethrins per cent.
			Grams		
1	I	5000	0·086	Unopened	0·57
2	I	5000	0·108	Half opened	0·8
3		5000	0·161	Opened	0·9
4		5000	0·263	Fully opened	0·75
5	II	5500	0·094	Unopened	0·82
6		5500	0·108	Half opened	0·83
7		5500	0·180	Opened	0·92
8		5500	0·294	Fully opened	0·71
9	III	5500	0·086	Half opened	0·76
10		5500	0·125	Half opened	0·79
11		5500	0·195	Opened	0·91
12		5500	0·217	Fully opened	0·79

Altitude.—Table II indicates that whereas pyrehrins can profitably be cultivated at altitudes of 5,000 ft. to 8,000 ft. above sea-level, an altitude of 6,000 ft. represents the optimum height for the cultivation of this plant in Kashmir.

TABLE II

S. No.	1	2	3	4	5
Locality	I	II	III	IV	V
Altitudes feet above sea-level	5000	5500	6000	7000	8000
Total Pyrethrins of sun-dried samples per cent.	0·95	1·02	1·1	1·01	1·0

An interesting point is revealed in Table III with respect to the mode of drying. Sun-dried flower-heads show a higher pyrethrin percentage than those dried in the shade. This is due to the humid weather in Kashmir during the harvesting period when the flower-heads remain in contact with moisture for too long in shade and cause decomposition of the pyrethrins.

TABLE III

S. No.	1	2	3	4	5
Locality	I	II	III	IV	V
Pyrethrin contents of flowers dried under sun : per cent.	1·02	0·98	0·95	1·01	0·96
Pyrethrin contents of flowers dried in shade: per cent.	0·87	0·92	0·89	0·91	0·90

It has, however, been found that flower-heads dried partly in the sun for three days and subsequently in shade contain a higher percentage of the active principles. A detailed investigation of this is in hand.

AGE OF THE PLANTATION

An examination of the flower-heads in respect to the age of the plantation reveals (Table IV) a gradual fall in the active-principle content from year to year. This is probably due to the exhaustion of soil and investigation in connection with the soil conditions and manuring is progressing.

TABLE IV

Locality	I	II	III
Altitude (in feet above sea-level)	5000	5000	5500
Plantation age at the time of harvesting : years	4	3	2
Total pyrethrins or sun-dried samples : per cent.	0·95	0·96	1·02

Locality	Krewa Feth Garh	Brimel Lewar
Pyrethrin content : 1943 crop per cent.	0·9	0·92
Pyrethrin content : 1944 crop. per cent.	0·75	0·85

All the assays described above have been conducted by the method of Tattersfield and Hobson (*Drugs and Calenicals*, by Garratt, p. 259).

I. C. CHOPRA.
M. L. DHAR.
K. L. HANDA.
M. HABIBULLAH.
P. ASSA NAND.

Drug Research Laboratory,
Jammu Tawi (Kashmir),
February 9, 1945.

THE OCCURRENCE OF A PSEUDOBRANCH IN THE FAMILY *OPHICEPHALIDAE* (TELEOSTOMI)

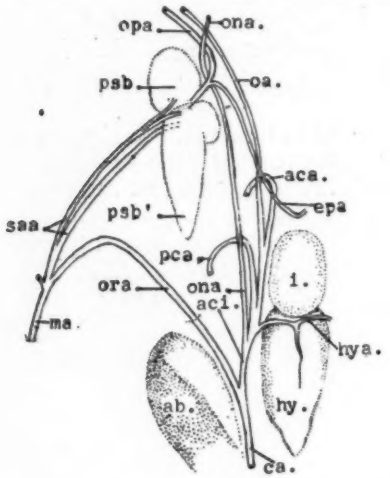
DURING the course of the study of the embryology of the food-fishes of Mysore, it was noticed that the head sections of the fry of *Ophicephalus gachua* (Ham.) disclosed the presence of a pseudobranch,—a structure which Day[1] described to be absent in the family Ophicephalidæ. In order to decide that it was not a larval feature, adults of *Ophicephalus* and *Channa* were dissected, where also a pseudobranch is now noticed to be present and, therefore, its disposition and vascular supply were studied. Further, it is proposed to describe in this note the arterial vessels of the head in *Ophicephalus* and *Channa*, since no account of the same is available for the former which is studied as a type of bony fishes in our colleges.

In the *Ophicephalus* fry (24 mm.), the pseudobranch is situated anterior to the branchial cavity and in a ventral dissection, it is noticed to be covered over partially by the adductor muscle extending between the pterygoquadrate and the parasphenoid. The orbital artery arising from the lateral dorsal aorta gives a branch to the pseudobranch which is its source of blood supply; the efferent pseudobranchial artery arises from the anterior end of it and goes off to the eye as the ophthalmica magna artery. A connection between the efferent pseudobranchial artery and ophthalmica magna artery with the arteria carotis interna is not noticed.

Adults of *Ophicephalus striatus* Bloch., *O. punctatus* Bloch., and *Channa orientalis* Bl. Schn., were examined. The pseudobranch situated far anteriorly to the branchial cavity is completely covered over by the adductor muscle. When the muscle is taken away, the pseudobranch, pink in colour, is seen in two parts: an oval anterior (Text-Fig. psb.) and a longish conical posterior with a medial protuberance (*psb'*.).

The vascular connexions of the pseudobranch in the adult *Ophicephalus* are different from those of the fry. In the adult, the carotid artery (ca.) arising from the united third and fourth efferent branchial arteries proceeds anteromedially to the auditory bulla (ab.) dorsally to the parasphenoid. It gives off a large orbital artery (ora.) (erroneously referred to as external carotid) and runs intracranially passing dorsally to the parasphenoid as before. The anteria carotis interna (aci.) now gives off a large orbitonasal artery (ona.) which passing dorsally to the parasphenoid emerges laterally near the pseudobranch and runs in the roof of the mouth to nasal region; a hypophysial

artery (hya.) which uniting with its companion gives off a small artery posteriorly; a slender optic artery (oa.) proceeding on the ventral



Drawing of the pseudobranch and associated arteries of *Ophicephalus striatus* Bloch. (ventral dissection, enlarged).

aspect of the optic nerve to the eye; a large posterior cerebral artery (pca.) vascularising the saccus vasculosus region and an anterior cerebral artery (aca.) proceeding to the forebrain region. The orbital artery runs in a canal in the prootic and emerges from the anterior trigeminofacialis orifice. It runs anteriorly to the medial hyomandibular projection on the mesial aspect of the bone and divides into two principal branches; one goes off as the mandibular artery (ma.) while the other proceeds anteriorly and enters the pseudobranch as in *Channa* or divides into two before opening into the same as in *Ophicephalus* (saa.). This vessel from the orbital artery is a secondary connexion supplying arterial blood to the pseudobranch. From the pseudobranch, there arises the efferent pseudobranchial artery (epa.) which after giving off a large ophthalmica magna artery (opa.) proceeding to the eye, runs posteriorly as a slender vessel and anatomoses with its fellow from the opposite side in front of the hypophysis (i., hy.).

While the description given above holds good for a number of dissections, two important variations have been noticed. In one specimen, one of the afferent branches to the pseudobranch, instead of terminating in the organ runs further as the orbitonasal artery and in the same specimen, the orbitonasal artery arising from the arteria carotis interna is, however, absent; in another specimen, in addition to the secondary afferent artery a small branch from the orbitonasal artery also supplies the pseudobranch before the latter runs to the nasal region.

I wish to express my sincere thanks to Prof. A. Subba Rau for help and to Mr. P. E. P. Deraniyagala, Director of Museums, Pelmadulla, Ceylon, for specimens of *Channa*.

Department of Zoology,
Intermediate College, L. S. RAMASWAMI.
Mysore,
November 20, 1944.

1. Day, F., *Fauna of British India: Fishes*, **1889**, **2**, 359. 2. Goodrich, E. S., *Structure and Development of Vertebrates, London*, **1937**.

INTERESTING MODE OF THE LIFE-CYCLE OF THE LUNG WORM, *VARESTRONGYLUS PNEUMONICUS* BHALERAO, 1932

THE lung worm, *Varestrongylus pneumonicus*, was discovered by the writer in 1932 from the bronchi of the goat, *Capra sibiricus*, and the sheep, *Ovis hodgsoni* and *O. nahura*, at Mukteswar. It has since been recorded from goats and sheep in the hills of Bengal, Punjab and the N.W. Frontier Province. This worm affects a large percentage of goats and causes heavy mortality. Because of the great economic importance of this parasite it was decided to study its life-cycle. At the outset, attempts were made to ascertain if it had a direct life-cycle like most of the strongyles. The first-stage larvæ, hatched from the eggs, were kept in culture at varying temperatures, to see if they underwent any change of structure and attained the infective stage. The larvæ lived in culture for eighty days, but no change of structure was noticed except a reduction of granules in the cells of the intestinal wall. Two conclusions could be drawn from these observations. The first and most improbable one being that the first-stage larvæ themselves might infect the definitive hosts, and the second that some intermediate host might be intercalated in the life-cycle of the parasite. In order to verify the former hypothesis the first-stage larvæ were fed to kids, confined to stalls and fed on tree-leaves. Autopsy of these animals after three months revealed that they had not been infected. Attempts were then made to see if the larvæ underwent some change on coming in contact with the commonest land molluscs at Mukteswar. The molluscs tried were *Macrochlamys* (*Euaustenia*) *cassida* and *Girasia* sp. The latter could not be infected, but the former picked up the infection readily. Within 24 hours after contact with these snails, the first-stage larvæ were transformed into the second-stage and these later became infective larvæ. The infective larvæ were localised on the foot and the mantle of the snails. The infected snails died within three weeks of the infection, but it was observed that the infective larvæ continued to live for more than a week after the death of the snails. Large number of larvæ recovered from the dead snails were drenched to some kids which, as before, were confined to a stall and fed on tree-leaves. The control animals were kept by the side of infected ones and were similarly fed. Ten weeks after the infection, the infected as well as the control animals, were slaughtered. Examination

of lungs revealed the presence of *V. pneumonicus* in the infected animals only, the controls being completely free. It has thus been proved that the lung worm, *V. pneumonicus* utilises the land snail, *Macrochlamys* (*Euaustenia*) *cassida*, as an intermediate host for completion of its life-cycle.

Veterinary Zoology Section,
Imperial Veterinary Research
Institute, Izatnagar, G. D. BHALERAO.
January 22, 1945.

ON THE PATHOGENICITY OF *SETARIA CERVI* (RUD. 1819) IN BUFFALOES

THE worm is generally considered non-pathogenic; but there are a few records of its accidental pathogenicity in literature. Purvis[2] states to have seen the worm associated with pathological lesions on four occasions: (1) with a patch of hæmorrhagic inflammation on the visceral peritoneum, about five inches in diameter; this coincided with the presence of some six to eight worms; (2 & 3) with fibrinous peritoneal exudate; and (4) with calcified material of similar appearance. Poisson and Buck[1] point out that while *S. cervi* usually occurs in very large numbers in the peritoneum and appears not to have any pathological effect, it may occur in other organs such as lymphatic tissues, spleen and right heart, where the parasite may be pathological.

The author's material consists of small intestine with a parasite embedded in each; these having been regularly collected from twenty of the one year-old buffalo calves. On the average, six such pieces per animal could be collected.

The material can be grouped into:—

(1) The parasite lying between the muscular and serous membranes.

(2) The parasite being coiled at one end, the other half being straight under the visceral peritoneum.

(3) The parasite with about anterior one-fourth out in the peritoneal cavity and the rest coiled in a loop under the serosa, the parasite being probably in a state of emergence.

(4) The parasite lying in a degenerated condition in the same site as mentioned for the above three categories.

In all these pieces in the living state, the parasites were throughout surrounded by a reddish zone. The pieces were fixed in Buion fluid and then transferred to 50 per cent. alcohol after 24 hours. After keeping them in 50 per cent. alcohol for seven days, serosa from one half of a piece was stripped off with the parasite embedded in it and was cleared in creosote. The other half of the piece was used for section cutting. The part cleared with creosote presented the anterior part of the parasite in its full form. This was surrounded by a stained zone of cells corresponding to the 'red zone' seen with the naked eye. Fibrous tissue which had remained unstained surrounded the stained zone. In the microphotograph the parasite is surrounded by endothelial cells and there is slight congestion. The section on the whole gives an appearance of a nodule.

Transverse Section of Serosa with *S. cervi* embedded in it × 450

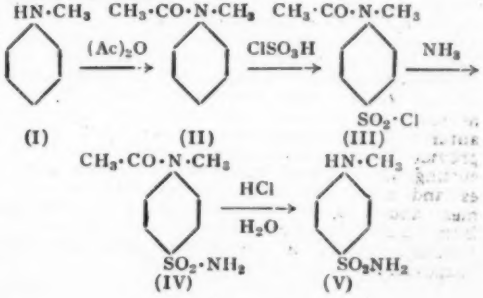
The regular appearance of the parasites in the sites mentioned and the fact that they set up a reaction in these sites, shows that the parasite is definitely pathogenic. The peculiarity of their disposition, i.e., lying spirally under the serosa, in a state of emergence and a degenerate appearance with the half of the parasite coiled at one end and the other half straight as though not having been successful in emerging, shows that the parasites pass sometime in these tissues before final emergence.

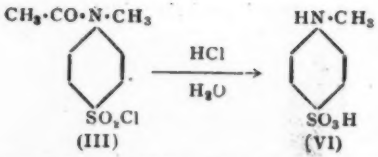
Military Dehydrated
Meat Factory, Agra, M. M. SARWAR.
February 6, 1945.

1. Poisson, H., and Buck, G., *Bull. de la. Soci. de Pathologia Exotique*, **1936**, **29**, 933–34. 2. Purvis, G. B., *The Veterinary Record*, May 9th, **1931**.

A NEW SULPHONAMIDE

ON referring to literature neither 4-N-methyl-amino benzene sulphonamide nor its intermediates were described. Therefore the total synthesis of 4-N-methyl-amino benzene sulphonamide was undertaken according to the following scheme.





(III) (VI)

N-methyl-acetanilide (II).—20 Gms. methyl-aniline (I) (b.p. 192° C.) was reacted with equal weight of acetic anhydride. Much heat was generated. On cooling, the mixture was poured into an equal volume of water. Methyl-acetanilide did not crystallise even on keeping in the refrigerator for several days. The aqueous layer was decanted and a few c.c. of strong ammonia were put in it, when the whole crystallized in a mass. On recrystallization from benzene, it melted at 100° C. (yield theoretical).

4-N-methyl-acetamino benzene sulphon chloride (III).—The procedure for this preparation is a slight modification of the usual method. In a 200 c.c. beaker was placed 117 gms. (10 mols.) of chlorosulphonic acid. This was cooled to — 5° C. and 14·9 gms. (1 mol.) of (II) was added in one hour. The temperature was maintained below 5° C. during the addition. The mixture was then heated for two hours at 60° C. and poured on a large quantity of crushed ice. Sulphon chloride precipitated in a yellowish mass, which settled down quickly. The acid water was decanted—the precipitate was taken up in chloroform, the solution was dried with anhydrous calcium chloride. On the removal of chloroform 24 gms. of the product were obtained (yield 50 per cent.). After several recrystallizations from benzene pure sample of (III) was obtained (m.p. 126° C.).

4-N-methyl-acetamino benzene sulphonamide (IV).—To 4·8 gms. of (III) contained in 50 c.c. Erlenmeyer flask, was added 50 c.c. of concentrated ammonia. The mixture was heated on a water-bath until a volume of 10 c.c. remained and then made neutral with dilute acetic acid. A precipitate of (IV) was obtained weighing 4 gms. (90 per cent. yield). Several crystallizations from 66 per cent. alcohol gave a sample of (IV) (m.p. 155° C.).

4-N-methyl-amino benzene sulphonamide (V).—To a solution of 2·5 gms. of (IV) in 25 c.c., absolute ethyl alcohol and 20 c.c. of concentrated hydrochloric acid was added. The resulting solution was heated for 30 minutes until a volume of 10 c.c. remained. Addition of water gave a clear solution showing complete deacetylation. It was made ammonical and a precipitate weighing 2·1 gms. (yield 85 per cent.). Successive crystallization from dilute alcohol gave a purified sample (m.p. 166° C.).

4-N-methyl-amino benzene sulphonic acid (VI).—To 2 gms. of (III) in 100 c.c. Erlenmeyer flask, was added a solution of 25 c.c. hydrochloric acid and 25 c.c. water. A clear yellow solution resulted after refluxing for a few minutes. After a further heating of 20 minutes and cooling no crystals of insoluble hydrochloride separated. On further evaporation of the solution and cooling to 0° crystals were obtained, which on recrystallization from alcohol were obtained in a purified form and decomposed at 244° C.

SUMMARY

1. 4-N-methyl-amino benzene sulphonamide has been prepared according to the general procedure with some modifications.

2. The action of chlorosulphonic acid on methylacetanilide gave substitution in 4- position in accordance with general rule, which was confirmed by its sulphonic acid.

3. All the compounds (II), (III), (IV) and (V) are very soluble in all solvents and much caution is to be exercised in crystallizing them.

4. Contrary to expectation amide (V) was found to be a lower melting compound than (IV) which has a higher molecular weight.

Hyderabad (Dn.), HABIB HASSAN.
February 5, 1945. LAL MOHAN SRIVASTAVA.

AGRICULTURAL RESEARCH IN U.S.S.R.

ACCORDING to current information, scientific workers at the Leningrad Institute for Plant Culture who were evacuated early in the war have now returned, and the restoration of the greenhouses, laboratories, and other equipment destroyed, is under way. The experimental station is situated three miles from Pavlovsk, near Leningrad, and had given major attention to the development of improved varieties of fruits. While many of the collections were removed to Germany and the remainder neglected, seeds sent to other parts of the Soviet Union have been found to give normal results. It was expected that the autumn of 1944 and the spring of 1945 would provide farm nurseries with 100,000 strawberry cuttings, 50,000 fruit trees, 60,000 currant bushes, and many other plants while, by next summer about 3,000,000 seedlings and cuttings from fruit trees and bushes will be ready. Extensive plans for scientific research are also being made.

Reorganization and expansion are also going on at the Moscow Botanic Gardens, where it is planned to enlarge the area from 250 to 750 acres. The work is organized under sections of plant evolution, experimental ecology, cultivated plants, dendrology, horticulture and floriculture.

The Academy of Sciences has established an experiment station in Northern Siberia, known as the Mountain Targa Station. Located in the Nkrivio Kliuch Valley near the city of Voroshilovussurisky, breeding and selection programs are under way looking toward the development of better crops for cold, short-season regions, the production of hardy fruit trees and bushes, and the adaptation of local wild species to food and medicinal purposes. New methods developed at the station are said to have brought about a potato production of about 12 tons per acre in large-scale fields.

—*Experimental Station Record*, 92, 160 (1945).

REVIEWS

A Treatise on Applied Hydraulics. By Herbert Addison. (Messrs. Chapman & Hall, Ltd., London), 1944. Pp. viii + 614. Price 32/-.

In this third edition of Prof. Addison's treatise on Applied Hydraulics, he has expanded and revised the excellent second edition. The Preface to the first edition is worth quoting, as it explains the author's purpose:

> "The purpose of this book is to present a compact summary of the fundamental principles of hydraulics and of the manner in which they are applied by the engineer. Readers who have particularly been kept in mind are those whose work is not directly connected with hydraulics but who require to be kept in touch with the main outlines of hydraulic practice. .... For their benefit the book is divided into two parts, so that when used as a work of reference only the second part dealing with practical applications need as a rule be consulted."

The enormous amount of information contained in less than six hundred pages has only been rendered possible by say, careful condensation and exclusion of what is unessential: yet the treatment is always adequate for the purpose in view and the enlarged Bibliography is helpful. Here, however, all references to recent advances in India is omitted. Purely a serious oversight. There is no reference to the Gibb module, the crump adjustable proportional module (semi-module) nor to the various excellent papers written in India on this subject: while the only reference to Sacey is in the Bibliography (item 72) under the heading "The Sacey Theory of Non-Stability".

It is to be hoped that Prof. Addison will look up the Central Board of Irrigation Publications before his next edition is released. To us in India, the omission is less important: but references to recent Indian advances would be of great help to workers in other countries, including Egypt. The explanatory notes in small type are most helpful, especially those in the chapter on "Flow through Closed Conduits," which give the clearest exposition of frictional loss in closed conduits which I have yet seen. This should be read and re-read by all irrigation engineers.

The references to earlier and later paragraphs are admirable and make it easy to true the full argument from basic theory to its final application without having to read anything which is not general to the particular problem.

The book is well balalanced and clearly produced and well up to the excellent standard we have come to expect from the House of Chapman & Hall.

This is a valuable book of reference.

C. C. Inglis.

Exercises in Human Physiology. By Sir Thomas Lewis. (Messrs. Macmillan & Co., Ltd., London), 1945. Pp. xiv + 103. Price 3/6.

When a medical student enters the clinical studies from the preclinical, he experiences a discontinuity in the transitional period. He feels that he has to shed some of the past, and is apt to ponder over the usefulness of his preclinical studies then and after. Sir Thomas Lewis' little book smoothens out his difficulties and provides an admirable preparatory to clinical work. This little book will show him that the application of his previous knowledge of Physiology to his immediate clinical problems makes him more fit to deal with the latter; he could apply the previous laboratory methods which he has learned, to human material which he encounters in the hospital with success. The book gives a concise and lucid account of the practical problems of Human Physiology and its size would enable it to be included in the regular curriculum and would not add any heavy burden to the students' lot; on the contrary, it will arouse interest, as he himself would take the place of the laboratory animals. Instead of passing from studies on animals to those on abnormal humans directly, this book provides an intermediate stage of studies on the normal human beings, thus bridging the gulf between the preclinic and clinical eras in medical studies.

The Gondwana and the Gonds. By Inderjit Singh. (The Universal Publishers, Ltd., The Mall, Lucknow), 1944. Pp. 201. Price Rs. 12.

Primitive economics is a somewhat neglected subject everywhere, particularly so in India, where there is not yet a sufficient number of anthropologists to deal with questions connected with the vast tribal population. Dr. Inderjit Singh, in the volume before us, has tried to give us a picture of the economic life of the Gonds. Within the short space at his disposal, it has not been possible for him to go into illustrative details, but he has broken new ground in marshalling the various forces, natural, religious, historical and cultural, in the make up of the economic Gond. Having served a long apprenticeship in anthropological theory and field work under his able teachers in the Lucknow University, Dr. Singh, with the knowledge he possesses of tribal dialects, creates an impression of high objectivity in whatever he has written. This is as it ought to be. It is not possible in this short review to summarise his theme, but readers will find the chapters on "Tribal Settlement and Social Stratification", on the *Gotul* or youth-house, on "Economic Leadership", and the final chapter on "Cultural Contacts and Acculturation" particularly interesting.

Tribal India seems to present almost the same pattern of problems everywhere—ruthless exploitation, total neglect, or half-hearted measures of relief, by those charged with the duty of safeguarding their interests. Dr. Singh argues passionately for a more sympathetic and scientific treatment of tribal problems in Gondwana, for a craft-based system of education and for the conservation of the several trails of value in Gond culture.

A. AIYAPPAN.

Vijnana mattu Sahitya. By K. S. Savanur. (The Students' Own Book Depot, Dharwar), 1944. Pp. vi + 71. Price 12 annas.

This is a reissue in book form of ten articles in Kannada originally published in the *Samyukta Karnataka* Daily. The main theme is the place of Science in the modern world. It has become fashionable in many quarters to blame science for all the ills of the world and the author sets out to show how the fault is not of science but of those who misuse it, and he shows also how Art and Literature can be equally misused. The opinions of men like Generalissimo Chiang Kai-Shek, Sir Richard Gregory and Bertrand Russell have been quoted and commented upon. The author comes to the conclusion that the remedy for the ills caused by the misuse of science is to be found only in a still more extensive application of the method of science to all the fields of human activity. The connection between the various articles is not logically quite complete but the general theme is kept in view. The language is simple and vigorous, and, but for a few peculiarities not familiar to us in Mysore, easily intelligible. It would be such a good thing if the powers that be can be made to realise the truths set out in the book. As a first step, however, we hope that our voting public and its representatives will spend some time in perusing the book and convincing themselves of the truth of the view therein set forth.

T. S. S.

A Life of Travels. By C. S. Rafinesque. *Chronica Botanica*, Vol. 8, No. 2. (The Chronica Botanica Co., Waltham, Mass., U.S.A.; Macmillan and Co., Ltd., Calcutta), 1944. $2.50.

To fully appreciate the worth of Rafinesque, a naturalist of the 19th century, it would be necessary to consult his major works besides his *A Life of Travels* under review here. A perusal of his accounts of his travels does, however, help one in getting a glimpse into the life and doings of a versatile and untiring worker. Although it may appear to a casual reader that his interest lay in many fields of knowledge, yet it is clearly evident that the study and classification of plants, fishes and shells was the most important among them and received his best attention. His life was devoted to a never-ending quest in search of plants, shells, fishes, minerals, etc., and in the description and classification of the material collected during his excursions. Wherever he went, whatever other occupation for profession he undertook for the sake of earning a living, his insatiable desire to wander over the countryside in search of plants continued nearly to the end of his life.

Rafinesque travelled widely over North America and Southern Europe and wrote at length on the flora of the countries visited by him. Yet he never received his just due from his contemporaries. He was considered by them as eccentric, unreliable and unscientific in his judgment. So bitter was the feeling against him that he could never get any recognition for his labours by the orthodox men of science of his day barring perhaps a few exceptions. But Rafinesque's was a bold and indomitable spirit that could not be quenched with disappointments, defeats or disaster. He continued to work to the end in his own way and had to publish many of his works at his own cost.

Rafinesque first visited America in 1802 and returned to Europe in 1805. He settled down in Sicily where he stopped for ten years and worked a good deal on the local flora. Later forced by circumstances he returned to the United States for the second time when a great disaster overtook him. His work of twenty years of the best part of his life, comprising thousands of collections of plant species, shells and fishes; his manuscripts of many years of painstaking work were all lost in a shipwreck on the coast of America. But this did not deter him from beginning all over again and working for another two decades to contribute to the knowledge of the flora, the ichthyology and conchology of eastern North America.

Rafinesque himself believed that some day his labours would receive their just due. In vindication of his contribution to the natural history of eastern North America during the 19th century comes the following appreciation of this versatile man whose intelligence bordered on that of the genius. Prof. Elmer D. Merrill, an eminent botanist of international renown who writes the foreword to the above republication of Rafinesque's travels, says, "In spite of Rafinesque's idiosyncrasies, in spite of his careless work, in spite of his constant and often caustic criticism of his associates, much that he accomplished was worthwhile." In republishing *A Life of Travels*, the *Chronica Botanica*, a journal devoted to the science of biology, has but given the meade of praise and recognition that was Rafinesque's—a descriptive biologist's due—in the 19th century.

L. S. S. KUMAR.

PSYCHOLOGY AND EDUCATIONAL SCIENCE*

IN his address, the President referred to the problem of Language and Education in India and clearly indicated the scope of the problem and the course the controversy has taken, finally giving his suggestions for solving the problem. He traced the history of the century and a quarter-old problem in brief and pointed out how Dr. West and Mr. Paranjape introduced the element of objectivity into the problem, by publishing some statistical data. Referring to the introduction of the option of answering History and all Classical Language papers of the Matriculation Examination of Bombay University from 1925 onwards, either in English or in their mother-tongue, Dr. Kuppuswamy gave an account of the Analysis of results of 1929 Matriculation Examination made by Paranjape. He reported "that the median marks in history of those who answered in their mother-tongue was 67·6 whereas the median for those who answered in English was only 59·8". He concluded that there was no relationship between the extent of vernacularisation and weakness in English.

Then Dr. Kuppuswamy referred at length to the scheme of teaching the different subjects in High School through the mother-tongue as the medium of instruction started in Mysore in 1931, when History and Geography were taught in Kannada in some of the High Schools. By 1938 all the subjects were taught in the mother-tongue. He quotes the Deputy Director of Public Instruction, Mysore, to have stated in his report, "In fact the pupils with vernacular medium have secured a better percentage of passes as well as higher marks in English".

Dr. Kuppuswamy then refers to the statistical study regarding the effect of the change of medium of instruction upon college performance, taking into consideration the performance in the Intermediate Examination of candidates whose medium of instruction for the S.S.L.C. was Kannada and those whose medium was English. He finds "that in average marks in English there is a difference of 3·7 marks between the English medium Group and the Kannada medium Group". Finally he concludes barring the two subjects, English and Economics, which is a new subject of study, the continuation of English medium has not been a source of advantage to the English medium Group, nor the change from Kannada to English a source of handicap for the Kannada medium students. That is, the performance of the two groups in the College Examinations is about the same though the medium of instruction was changed with respect to some. Further this investigation clearly brings out the fact that there is a confusion in the minds of people concerning the "Knowledge of a Language" and "The Language as a medium of instruction".

Referring to the general belief that with the introduction of the mother-tongue as the medium of instruction, there may result a lowering in the standard of the knowledge and efficiency in English Language the President stated that the knowledge of the English language was not lowered when the medium of instruction was the mother-tongue, so long as English is taught as a language subject. The difference between the two groups with respect to marks in English probably indicates that greater attention should be paid to the teaching of English language for the Kannada medium students than what is being done now.

The concluding part of the speech referred to very useful remarks regarding the teaching of the mother-tongue and the problem of bilingualism in India.

* Abstract of Dr. B. Kuppuswamy's Presidential Address to the Section of Psychology and Educational Sciences, Indian Science Congress, Nagpur, 1945.

INDIA'S POSITION WITH REGARD TO HER COAL RESOURCES*

THE Presidential Address commenced with a review of India's coal reserves in relation to world resources. A brief reference was made to the formation of coal, its micro-structure, physical and chemical characters, and to the system of classification of coal as adopted by the Indian Coal Grading Board. A more detailed account was given of the occurrence of sulphur in coals and on methods of desulphurisation. It was suggested that low temperature coke industry, gas industry, by-product chemical industry, and pulverised coal firing should be introduced in an increasing measure for the proper utilisation of the different grades of Indian coal.

The problem of coal conservation was next discussed and a plea made for the introduction of vertical rotation of working, enforcement of complete stowing, and for the total stoppage of partial grading. Stress was laid on the proper utilisation of the different grades of coal for specific purposes, and the suggestion was made that the Railway Board should utilise inferior grade non-choking coals by introducing pulverised coal-firing in locomotive boilers, and thus release high grade coking and non-coking coals for more important uses. It was recommended that, in order to ensure maximum conservation of India's limited reserves of coal, there should be greater State control and intervention, and that malpractices should be stopped by strict legislation so that the coal industry might be placed on a sound footing; further, that the Central Government should adopt a *National Mineral Policy* and appoint a central advisory technical body like the National Research Council for working out the details.

The address concluded by referring to the serious lack of encouragement on the part of the authorities in the matter of teaching of geology—a subject of great importance and utility. The attention of the Government and University authorities was drawn to give this matter the earnest consideration it deserved, and an appeal was made to them to take immediate steps to improve this unhappy position, and to make adequate provision for proper training of students so that a larger number of qualified geologists and mining engineers would be available for rendering greater and more useful service to India.

* Abstract of Dr. N. N. Chatterjee's Presidential Address to the Section of Geology, Indian Science Congress, Nagpur, 1945.

SCIENCE NOTES AND NEWS

The report of the Director of the Pasteur Institute, Coonoor, for the year 1943-44 embodies an account of the results of routine and research activities. The Institute has carried antirabic treatment for human patients and for animals and details of statistical analysis of the number of cases receiving treatment during the year under review has been presented. Besides, the Institute has also carried out on a large-scale, routine laboratory examination for the benefit of hospital, dispensaries and practitioners. The research work of the Institute mainly consisted of investigation in Rabies and Tropical Eosinophilia. The relationship of the parasite originally found in the mid-brains of guineapigs experimentally infected with rabies street virus to the Negri bodies has been investigated and the suggestion has been put forward that Negri bodies may represent a stage in the life-cycle of the parasite. Clinical and laboratory findings in cases of Tropical Eosinophila suggest the possibility of an infection being responsible for the syndrome.

The Nutrition Research Laboratory during the year under review carried out work on the analysis of foods. Extensive investigations have been carried out on 'anti-thiamin' factor present in certain cereals. The Pyridoxin (vitamin B) content of a number of foods has been determined, using the insect larvæ technique.

Works on experimental fluorosis and investigation into relationship between dental caries and fluorosis have been continued clinical and field investigations on "nutritional diarrhœa" and infantile beriberi in Cocanada have been carried out. Educational and advisory work of the Institute were continued.

The Thirty-Seventh Annual Report of the Central Committee of the Pasteur Institute Association which appears in the latter part of the volume under review records the statements of receipt and payments, the manufacturing and trading accounts, the profit and loss account and the balance sheet.

One of the achievements of the Khandesh Cotton-Breeding Scheme, which aims at increasing the ginning percentage of the prevalent cotton strain (known as Jarilla), is that quality yield was produced. This was possible by hybridizing Jarila strain with a higher ginning cotton. The synthetic cultures so obtained are in their seventh generation this year. Results in the past three years show that three of the above cultures gave 2 to 4 per cent. more ginning than Jarila, and also appeared to be better yielders. Their trial on large-scale in different places is under way.

An improved strain known as Wagator has been recently released by the Cotton-Breeding Station, Viramgam, for multiplication and spread in the Wagad tract of over three lakhs acres in Ahmadabad District where a scheme for the improved Wagad cotton is financed jointly by the Indian Central Cotton Committee and the Bombay Department of Agriculture since May 1937. Wagator cotton is a synthetic type derived from a back-cross, being the quality cotton of South Gujrat. This is superior to local Wagad in yield of Kapas per acre, ginning percentage and spinning capacity. It is further capable of spinning better than local Wagad. Long-stapled, silky, Close-Bell races of Iran, outstanding Surtee Broach types, and early cottons from Russia have been extensively used in crossing with suitable Wagad types since then. As a result of this work, several promising types are now on hand. Experiments have shown that a cotton superior to Wagator would soon become available for the Wagad tract and which would be more profitable to grow.

With a view to take advantage of the provision made in the budget of the Central Government to allow cost incurred on research to be accounted as debit expenditure for purposes of the Excess Profits Tax, the Ahmedabad Mill Owners' Association has decided to start a Research Institute of Textile Technology at a cost of about 65 lakhs.

It is understood that the Government of India have constituted an industrial panel to examine and make recommendations regarding the manufacture of machinery for various industries, such as textile, sugar, paper, mining, cement, chemicals, etc. The Chairman of the panel is Mr. G. L. Mehta and among the members are Mr. P. F. S. Warren, Mr. Kirloskar, Mr. Mulgaokar and Mr. K. K. Birla.

With a view to meeting the increasing demand from Provinces and States for trained personnel in Veterinary Science and Animal Husbandry, the Government of India propose to increase the existing facilities at the Imperial Veterinary Research Institute at Izatnagar with effect from April 1945. The following courses of instruction are contemplated at the Institute:—(1) Poultry Course for four months; (2) Farm Manager's Course for three months; (3) Advanced Animal Husbandry Course (8 months); (4) Associate Diploma of the Institute (2 years); and (5) Specialized Training of Students in Research Methods.

In connection with post-war development plans, facilities for imparting specialized training at the Institute exist and it is proposed to admit 24 students, 12 for Animal Nutrition Research and 12 for Poultry Research.

A University Grants Committee, on the lines suggested in the Sargent report for post-war education in India, has been appointed by the Government of India.

The following students of the Imperial Agricultural Research Institute, New Delhi, have been awarded the diploma of the Institute (Assoc.I.A.R.I.) after completion in September 1944 of the two-year post-graduate course:—

Agricultural Botany and Plant Breeding:

(1) Parmanand Swarup Bhatnagar, M.Sc. (luck.), (2) S. Murtaza Hasan, B.Sc.Ag. (Agra), M.Sc. (Ben.), (3) Clarence Arthur Gideon, B.Ag. (Bom.), (4) Balabhadra Misra, B.Sc.Ag. (Nagpur), (5) Amar Nath Khanna, B.Sc.Ag. (Agra), M.Sc. (Ben.), (6) Ranjit Singh, B.Sc.Ag. (Punj.). *Entomology*: (1) Girdharilal Narain-das Bhatia, B.Ag. (Hons.) (Bom.), (2) Rattan Lal, M.Sc. (Punj.). *Mycology and Plant Pathology*: (1) Jagadisha Chandra Raghunath Mhatre, B.Sc. (Bom.), (2) C. S. Ramamurthy, B.Sc. (Hons.) (Mad.). *Agricultural Chemistry and Soil Science*: (1) Nayani Veera Mohana Rao, B.Sc. (Andhra), M.Sc. (Ben.). *Sugarcane Breeding and Cultivation*: (1) Hassan Luqman, B.Sc.Ag. (Agra), M.Sc. (Ben.), (2) Gursham Singh, B.Sc.Ag. (Punj.), M.Sc. (Ben.).

The Government of Mysore have sanctioned the constitution of a Board of Agricultural Research, with the Minister of Agricultural Research as Chairman, the Vice-Chancellor of the Mysore University as Vice-President, and the Director of Agriculture as Secretary and Principal of the Central College, Bangalore, Heads of the Scientific Sections of the University and Heads of the Sections of the Department of Agriculture as members. The Board will co-ordinate the results of scientific and agricultural research, and see to the applicability of advanced scientific knowledge in practical agriculture.

The Nawab of Chhattari, President of the Nizam's Council, in a message to the inaugural meeting of the Hyderabad Post-Graduate Association of the Study of Homeopathy, expressed appreciation of the attempt on the part of qualified medical practitioners to understand parallel schools of medicine. He said: "Knowledge is the heritage of all mankind and it is the sacred duty of all interested in the well-being of their fellowmen to seek knowledge from every possible source. The various systems of medicine contain some valuable truths, and it is for us to invoke the help of science to sift and collect truth—whatever the source, India is a poor country and has a very large population. One of her greatest needs is to find means of relief for her ailing millions within her economic resources."

A committee is to be appointed to advise the Government of India on the steps to be taken to establish the manufacture of penicillin. This was one of the decisions taken at the Eighth Meeting of the Governing Body of the Council of Scientific and Industrial Research, held on March 18, the Hon. Sir Ardeshir Dalal, Member for Planning and Development, presiding.

The Government of India have decided to set up a Central Waterways, Irrigation and Navigation Commission, a Central Fact-finding, Planning and Co-ordinating Organisation which will examine the potentialities of India's rivers and assist in the co-ordinated and multipurpose development of rivers passing through more than one Province or State. The Commission will be available to advise the Central, Provincial and State Governments on waterways, irrigation and navigation problems throughout the country. It will conduct surveys and investigations to secure planned utilisation, control and regulation of water and waterways in consultation with Provincial and State Governments. The Commission will advise the Centre in respect of principles governing water rights, inter-Provincial disputes and on the appropriate basis of agreement between the parties in dispute. It will also advise the Central Government in regard to the settlement of priorities as between various projects.

The Governing Body of the Indian Research Fund Association, at its annual meeting, approved a programme for medical research for 1945-46, as drawn up by its Scientific Advisory Board, and sanctioned the continuation of 35 research schemes costing about Rs. 6½ lakhs and fourteen new schemes estimated to cost over Rs. 81,000.

A clinical research unit is being set up at the Tata Memorial Hospital, Bombay, and a Clinical Research Advisory Committee will shortly be appointed to draw up a programme for clinical research in India.

The Government of Madras have subsidised a scheme for the investigation by the Indian Institute of Science, Bangalore, of the mechanism of the microbiological formation of sulphur in Kona, Kistna District.

MAGNETIC NOTES

Magnetic conditions during March 1945 were slightly more disturbed than in the previous month. There were 17 *quiet* days, 12 days of *slight* disturbance, and 2 days of *moderate* disturbance, as against 10 quiet days, 20 days of slight disturbance and 1 day of moderate disturbance during the same month last year.

The quietest day during the month was the 22nd and the day of the largest disturbance the 28th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
1–4, 7, 9, 10, 13, 17–19, 21–23, 25, 30 and 31	5, 6, 8, 11, 12, 14–16, 20, 24, 27 and 29	26 and 28

No magnetic storms occurred during the months of March in 1944 and 1945.

The mean character figure for the month of March 1945 was 0·52 as against 0·71 for March 1944.

M. PANDURANGA RAO.

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INDIA METEOROLOGICAL DEPARTMENT

Applications in prescribed form will be received up to 10th May 1945 from candidates belonging to all communities for temporary posts of (1) Professional Assistant on Rs. 170-10-290-15-350; (2) Meteorological Assistant on Rs. 130-8-210-10-270; and (3) Assistant on Rs. 100-5-150-10-250. **Age limit:-** 28 years (31 years for Scheduled Castes only) on 10th May 1945 for all posts. **Minimum qualifications:-** For (1) M.Sc. or B.Sc. with Honours and (2) and (3) Graduate in Science. Particulars and application forms available from the Director-General of Observatories, Lodi Road, New Delhi, by sending stamped and addressed envelope.

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